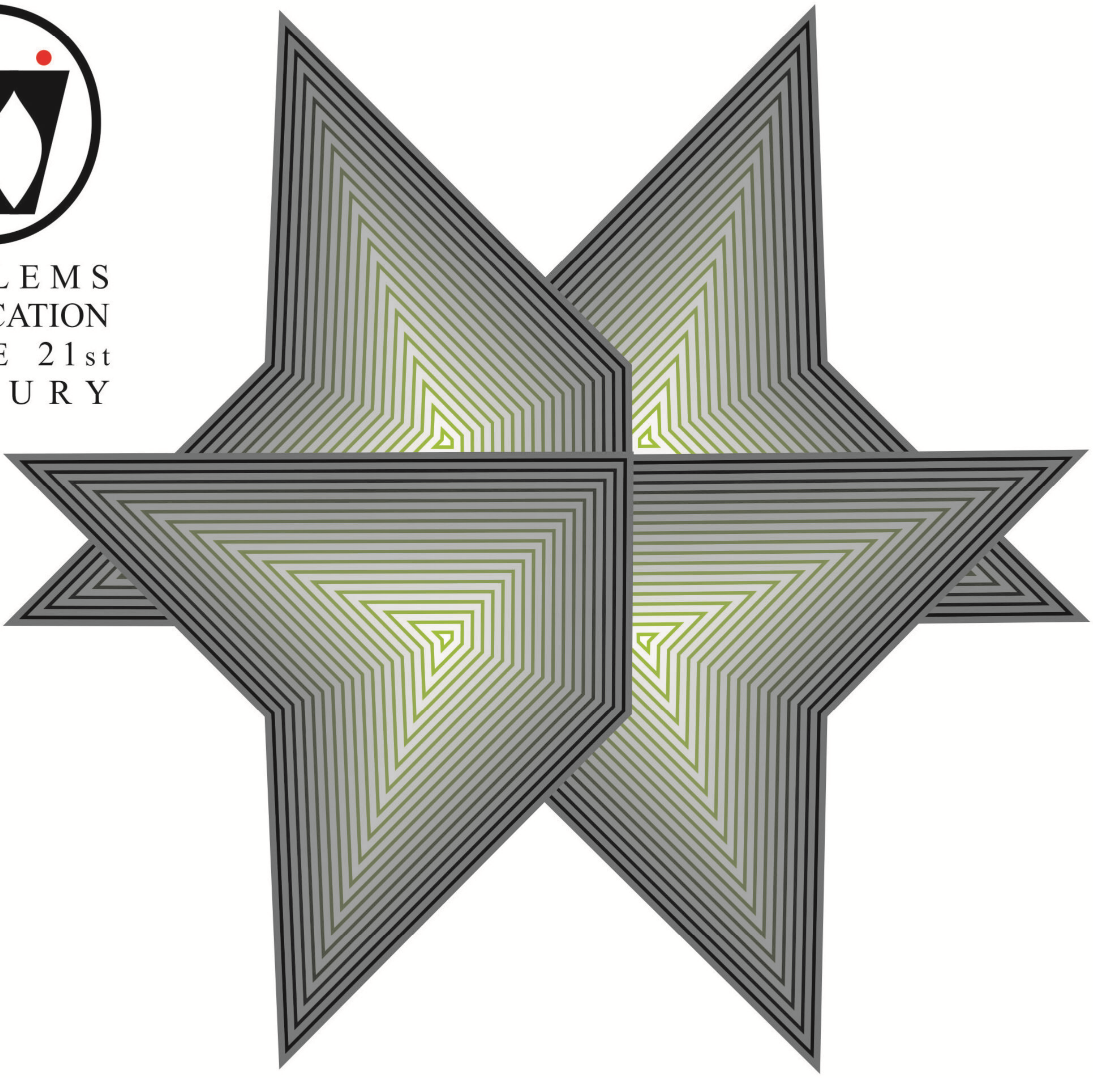
Vol. 80, No. 1, 2022

PROBLEMS
OF EDUCATION
IN THE 21st
CENTURY



PROBLEMS
OF EDUCATION IN THE 21st CENTURY

ISSN 1822-7864
9 771822 786007

Problems of Education in the 21st Century,
ISSN 1822-7864 (Print) ISSN 2538-7111 (Online)

Vol. 80, No. 1, 2022

PROBLEMS OF EDUCATION IN THE 21st CENTURY

Scientia Socialis, Ltd., a member of the *Lithuanian Publishers Association and a member of Publishers International Linking Association, Inc. (Crossref)* in cooperation with SMC „Scientia Educologica“, Lithuania, *The Associated Member of Lithuanian Scientific Society, European Society for the History of Science (ESHS) and ICASE (International Council of Associations for Science Education)*

The articles appearing in this journal are indexed, listed, and abstracted in:

Emerging Sources Citation Index (ESCI) (Web of Science | Clarivate Analytics)
ERIC
Index Copernicus
EBSCO: Education Research Complete
Education Research Index Database Coverage List “Core” coverage
Central & Eastern European Academic Source Database Coverage List (EBSCO-CEEAS)
JournalSeek
Ulrich`s Periodicals Directory
Contemporary Science Association/AAP databases
Open Academic Journals Index (OAJI)
Zeitschriften Datenbank (ZDB)
GIGA Information Centre (Electronic Journals Library)
CNKI (China National Knowledge Infrastructure) Scholar
Turkish Education Index
Information Matrix for the Analysis of Journals (MIAR)
Directory of Open Access Scholarly Resources (ROAD)
Eurasian Scientific Journal Index
Crossref
ProQuest (ProQuest Central; ProQuest Education Journals)
Europub: Academic and Scholarly Research Publication Center
The Scientific Literature Database (Scilit)
QOAM
DOI
ResearchGate
Dimensions
SOBIAD
CEEOL (Central and Eastern European Online Library)

Publisher

Scientia Socialis, Ltd. in cooperation with SMC „Scientia Educologica“, Lithuania, the Associated Member of Lithuanian Scientific Society, the Association of Lithuanian Serials, European Society for the History of Science (ESHS) and International Council of Associations for Science Education (ICASE)

Editors-in-Chief

Dr., Prof. **Agnaldo Arroio**, University of Sao Paulo, Brazil
Dr., Prof. **Vincentas Lamanauskas**, Vilnius University & SMC „Scientia Educologica“, Republic of Lithuania

Editorial Board

Dr., Prof. **Boris Aberšek**, University of Maribor, Slovenia
Dr., Prof. **Saleh A. Alabdulkareem**, King Saud University, Saudi Arabia
Dr. **Monica Baptista**, University of Lisbon, Portugal
Dr., Prof. **Martin Bilek**, Charles University, Czech Republic
Dr., Prof. **Andris Broks**, University of Latvia, Latvia
Dr., Prof. **Marco Antonio Bueno Filho**, Federal University of ABC, Brazil
Dr. **Paolo Bussotti**, University of Udine, Italy
Dr., Prof. **Muammer Calik**, Trabzon University, Turkey
Dr. **Saša A. Horvat**, University of Novi Sad, Republic of Serbia
Dr., Prof. **Margaret Chan Kit Yok**, MARA University of Technology (UiTM), Malaysia
Dr., **Angela James**, University of Kwazulu – Natal, South Africa
Dr., Prof. **Vladimir S. Karapetyan**, Armenian State Pedagogical University named after Kh. Abovyan, Armenia
Dr., Prof. **Kuo-Hung Huang**, National Chiayi University, Taiwan
Dr. **Milan Kubiatko**, Jan Evangelista Purkyně University in Ústí nad Labem, Czech Republic
Dr., Prof. **Miroslaw Kowalski**, University of Zielona Gora, Poland
Dr., Prof. **Lay Yoon Fah**, University Malaysia Sabah, Malaysia
Dr. **Todar T. Lakhvich**, Belarusian State Medical University, Republic of Belarus
Dr. **Solange W. Locatelli**, Federal University of ABC, Brazil
Dr. **Eleonora Melnik**, Petrozavodsk State University, Republic of Karelia, Russia
Dr., Prof. **Danuše Nezvalova**, Palacky University, Czech Republic
Dr. **Osman Pekel**, Suleyman Demirel University, Turkey
Dr., Prof. **Yuriy Pelekh**, Rivne State University of Humanities, Ukraine
Dr., Prof. **Raffaele Pisano**, University of Lille, France
Dr., Prof. **Katarzyna Potyrala**, Pedagogical University of Cracow, Poland
Dr. **Costin Pribeanu**, Academy of Romanian Scientists, Romania
Dr. **Agneta Simeonsdotter Svensson**, University of Gothenburg, Sweden
Dr. **Uladzimir K**. **Slabin**, University of Oregon, USA
Dr. **Laima Railienė**, Scientific Methodical Centre „Scientia Educologica“, Republic of Lithuania
Dr., Prof. **Borislav V. Toshev**, Sofia University, Bulgaria
Dr., Prof. **Milan Turčani**, Constantine the Philosopher University, Slovakia
Dr., Prof. **Nicos Valanides**, Educational Robotics and Science Organization, Cyprus

Copyright of this issue is the property of Scientia Socialis, Ltd, Lithuania. By virtue of their appearance in this open access journal, articles are free to use, with proper attribution, in educational and other non-commercial settings

Index Copernicus (IC™ Value): 128.74 (2020); ICDS (Secondary Composite Index Broadcasting): 9.5 (2018). CGIJ OAJI: 0.350 (2018). H Index: 7 (2020)

Problems of Education in the 21st Century is an international, periodical, peer reviewed scientific journal, issued by the Scientia Socialis Ltd. in cooperation with SMC „Scientia Educologica“.

Address: Scientia Socialis, Ltd.
Donelaičio Street 29, LT-78115 Siauliai, Lithuania
E-mail: scientia@scientiasocialis.lt
Phone: +370 687 95668
WEB page: http://www.scientiasocialis.lt/pec

Contents

Editorial

EXPLORING ATOMS AND MOLECULES IN THE CLASSROOM: IS IT POSSIBLE?
Solange W. Locatelli 5

Articles

GENDER VARIATIONS FAVOURING MALE STUDENTS IN PERCEIVED NATURE OF LEARNING MOLE CONCEPT
Kenneth Adu-Gyamfi, Rejoice Elikem Vorsah 9

AN ENTREPRENEURIAL SCIENCE THINKING MODULE BASED ON THE SOCIOSCIENTIFIC ISSUES APPROACH WITH THINKING WHEEL MAP FOR PRIMARY SCHOOL STUDENTS IN STEM EDUCATION
Jamilah Ahmad, Nyet Moi Siew 30

IMPACT OF EXPERIENCING EVENT DESIGN WITH WEB 2.0 TOOLS ON PROSPECTIVE MATHEMATICS TEACHERS
Aybige Arabaci, Keziban Orbay 52

PROSPECTIVE PRE-SCHOOL TEACHERS' VIEWS ON STEM LEARNING IN GRADE 9: THE PRINCIPLE OF CONTINUITY IN EDUCATION
Dagnija Cedere, Inese Jurgena, Rita Birzina, Sandra Kalnina 69

PERCEPTIONS AND RECOMMENDATIONS OF FOREIGN LANGUAGE TEACHERS TO PREVENT CHILDREN VIOLENCE AND ABUSE: A CASE STUDY IN TISHK INTERNATIONAL UNIVERSITY STUDENTS IN ERBIL, IRAQ
Bunyamin Celik, Yunus Yildiz, Recep Bilgin 82

INTEGRATION OF ENVIRONMENTAL EDUCATION (EE) IN TEACHER EDUCATION PROGRAMS: TOWARD SUSTAINABLE CURRICULUM GREENING
Alma M. Corpuz, Teody C. San Andres, Julieta M. Lagasca 119

PRE-SERVICE TEACHERS' APPROACHES TO GUIDING STUDENTS IN PROBLEM SOLVING PROCESS
Fatma Cumhur 144

SITUATION OF SPECIAL EDUCATION IN BRAZIL AND CANADA DURING THE COVID-19 PANDEMIC
Rosana Carla do Nascimento Givigi, Denise Meyrelles de Jesus, Raquel Souza Silva 162

TEACHING AND LEARNING MECHANICS EXPLORED THROUGH THE USE OF THE 5E's EDUCATIONAL MODEL
Jean de Dieu Nkurikiyimana, Jean Uwamahoro, Kizito Ndihokubwayo 179

EVALUATION OF DISTANCE EDUCATION PROCESS IN SPORTS HIGHER EDUCATION
Uğur Özer 195

REFLECTIVE THINKING AND INQUIRY SKILLS AS PREDICTORS OF SELF-EFFICACY IN TEACHING MATHEMATICS
Mehtap Saracoglu 213

Information

INSTRUCTIONS FOR AUTHORS 232

This is an open access article under the
**Creative Commons Attribution 4.0
International License**

EXPLORING ATOMS AND MOLECULES IN THE CLASSROOM: IS IT POSSIBLE?

Solange W. Locatelli
Federal University of ABC, Brazil
E-mail: solange.locatelli@ufabc.edu.br

If you are a chemistry teacher, chances are you have already felt like doing an activity where students could manipulate and explore atoms or molecules in the classroom. Yes, that is right, touching, moving, uniting atoms to form molecules in a classroom, forming the most diverse substances that exist in the world, or at least observing these particles (atoms or molecules) under the microscope, as well as their constituents such as electrons and protons. But, is this possible? It is known that none of this is possible, but it would be desirable if it were, because in this way, students could better understand many phenomena of their daily lives, such as, for example, the burning of coal with the release of gases that, at a submicro level, involves the rearrangement of atoms for the occurrence of such a chemical reaction. Considering this, how to explore the particles in the classroom, which are inaccessible to the human senses, in a way that the student can understand, having an explanation of what is happening macroscopically, that is, of what he or she is observing (seeing) or even feeling, since in this case heat is released. How could we try to explain the natural world, what we experience in our daily lives?

In order to answer this issue, the question that has started this discussion is taken up again, about exploring atoms and molecules in the classroom and it can be said that yes, it is possible, but not directly as we would like it to be possible. Gilbert (2008) states that the elaboration of explanatory models is necessary, in order to help in the understanding of the phenomena of the natural world. These models can be expressed in representational levels, as proposed by Johnstone (1993), and with the following name proposed by Gilbert and Treagust (2009): macro, submicro and symbolic levels. Although other theoretical developments have already been suggested by several researchers (e.g., Talanquer, 2011), expanding this view of representational levels, we still consider the use described above to be fruitful to help students represent and explain a phenomenon of the natural world.

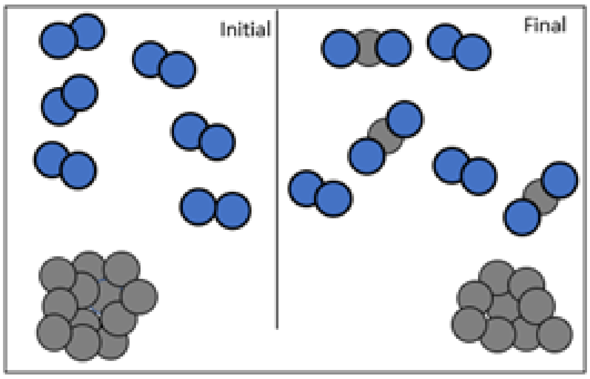
In the example of coal burning, the focus is often on understanding this specific phenomenon and then expanding it, if convenient, necessary, or desirable. Gilbert (2008) refers to "the macroscopic level is therefore a representation of a chunk of the world-as-experience that science is able to explore conveniently" (p. 4).

Continuing with the proposed example, imagine a piece of coal slowly burning, in which the release of gas is observed while this phenomenon occurs, which is called the macro level. Then, this knowledge can be expanded, adding other aspects as proposed by Talanquer (2011), which will help to better understand and characterize this and other levels, such as "different types, scales, dimensions, and approaches of our chemical knowledge" (p. 187). And, finally, maybe even approach, in a qualitative or quantitative way, the triplet components, depending on the need and purpose of what will be discussed in the classroom. In our case, the submicro level can be used, the one that refers to particles, in which a qualitative explanation can be attributed to the phenomenon under observation. An image can be used that will represent a scientifically accepted (very simple) model for burning coal, Figure 1:

ISSN 1822-7864 (Print) ISSN 2538-7111 (Online) https://doi.org/10.33225/pec/22.80.05

Figure 1

Submicro Level Representation of Burning Coal, Gray Balls Corresponding Carbon Atoms and Blue Balls, Oxygen Atoms



The model represented in Figure 1 was chosen, since it is very simple, and the teacher could use it in the classroom with the students. Thus, when observing the image presented, and at this point it will be very important to make it very clear, they can perceive that it is a representation, or rather, a possibility of representation at a submicro level for the phenomenon, and not the only one. What they are seeing is not a mini-photograph of what happens in the real world, on the contrary, it is an explanatory model, which will help in understanding the phenomenon. Wartha and Rezende (2011) contribute a very interesting idea about the concept of representation in which it "has a long history, which gives it a multiplicity of meanings. In Western philosophy, the idea of representation is linked to the search for appropriate ways to make the 'real' present, to learn it through systems of meaning." (p. 276), since in the case under study, the 'real' cannot be visualized, which would be the carbon atoms interacting with the oxygen gas molecules, in this way explanatory models are used, with their own meaning system, to help us in this task of bringing the 'real' closer to the student.

Regarding the representation at the symbolic level, the following chemical equation can be proposed for this purpose: $C(s) + O_2(g) \rightarrow CO_2(g)$. In order to prevent it from becoming a mechanical learning, it is necessary for the teacher to discuss the meaning of each representation made, connecting with the macroscopic level that is more accessible and concrete to the student. For the most experienced, it may seem very simple to associate the formula "O_2" with the representation of an oxygen molecule. However, for less experienced students, for example, in basic education, a dialogue discussion with students on this issue is recommended. Why do you write O_2 and not O and O? Once in a chemistry class, I myself observed that a couple of students spent about 20 minutes on this discussion of how they should write the representation of an oxygen molecule. This is due to the fact that symbols are loaded with meanings (Taber, 2009), and if this is not clear, learning will be impaired. In this case, it is further added that it is worth noting that the formula "O_2" is not an oxygen molecule, but a representation of an oxygen molecule, and so on. When this dialogic explanation is made, allowing students to expose their previous ideas, this can allow them to rethink about their internal representations, that is, a model that is stored in their memory, on a certain subject. What did he or she imagine the representation of an oxygen molecule would look like? Observing a drawing that the teacher makes on the board, or even an image, will enable monitoring at the meta level that will exercise control at the object level (Nelson & Narens, 1994). By developing this metavisual skill, the student will become aware of monitoring, controlling the acquisition, retention, retrieval, and modification of an image (Gilbert, 2008). This is reinforced by Locatelli and Davidowitz (2021) who emphasize the importance of metavisualization for the review of chemical concepts, metavisualization understood here as a "metavisual skill, where the student will monitor and specifically regulate their internal representations, helping him to build concepts in Science" (Locatelli et al., 2010, p. 76).

Thus, it is presented here, in summary, that it is possible to explore atoms and molecules in the classroom through models and representations. In this way, considering the complexity of the epistemology of chemical knowledge, in which a lot of care is needed on the part of the teacher, taking chemistry to their students in a critical way, developing scientific concepts, which in turn will lead them to become learners metacognitive, with autonomy to learn more and better.

Acknowledgments

To the São Paulo Research Foundation (FAPESP, 2018/26142-0) for the financing of the research project.

References

Gilbert, J. K. (2008). Visualization: An emergent field of practice and enquiry in science education. In J. K. Gilbert, M. Reiner, & M. Nakhled (Eds), Visualization: Theory and practice in science education (pp.3-24). Springer.

Gilbert, J. K., & Treagust, D. F. (2009). Introduction: Macro, submicro and symbolic representations and the relationship between them: Key models in chemical education. In: Gilbert J. K., & Treagust, D. (Eds), *Multiple representations in chemical education. Models and modeling in science education* (Vol 4., pp. 1-8). Springer. https://doi.org/10.1007/978-1-4020-8872-8_1

Johnstone, A. H. (1993). The development of chemistry teaching: A changing response to a changing demand. *Journal of Chemical Education*, *70*(9), 701-705.

Locatelli, S. W., & Davidowitz, B. (2021). Using metavisualization to revise an explanatory model regarding a chemical reaction between ions. *Chemistry Education Research and Practice*, 1, 1-14. https://doi.org/10.1039/D0RP00339E

Locatelli, S., Ferreira, C, & Arroio, A. (2010). Metavisualization: An important skill in the learning chemistry. *Problems of Education in the 21st Century*, *24*, 75-83. http://www.scientiasocialis.lt/pec/node/441

Nelson, T. O., & Narens, L. (1994). Why investigate metacognition? In J. Metcalfe & A. P. Shimamura (Eds.), *Metacognition: Knowing about knowing* (pp. 1–25). The MIT Press.

Taber, K. S. (2009). Learning at the symbolic level. In: Gilbert, J. K., & Treagust, D. (Eds), Multiple representations in chemical education. Models and modeling in science education (Vol. 4, pp. 75-104). Springer. https://doi.org/10.1007/978-1-4020-8872-8_5

Talanquer, V. (2011). Macro, submicro, and symbolic: The many faces of the chemistry "triplet". *International Journal of Science Education*, *33*(2), 179–195. https://doi.org/10.1080/09500690903386435

Wartha, E. J., & Rezende, D. B. (2011). Os níveis de representação no ensino de química e as categorias da semiótica de Peirce [The levels of representation in de teaching of chemistry and the categories of Peirce's semiotics]. *Investigações em Ensino de Ciências*, *16*(2), 275-290. https://www.if.ufrgs.br/cref/ojs/index.php/ienci/article/view/230

Received: *January 30, 2022* Accepted: *February 15, 2022*

Cite as: Locatelli, S. W. (2022). Exploring atoms and molecules in the classroom: Is it possible? *Problems of Education in the 21st Century*, *80*(1), 5-8. https://doi.org/10.33225/pec/22.80.05

Solange W. Locatelli	PhD, Center for Natural and Human Sciences, Federal University of ABC, Av. dos Estados, 5001 - Bangú, Santo André - SP, 09210-580, Brazil. E-mail: solange.locatelli@ufabc.edu.br ORCID: https://orcid.org/0000-0002-7639-6772

This is an open access article under the
**Creative Commons Attribution 4.0
International License**

GENDER VARIATIONS FAVOURING MALE STUDENTS IN PERCEIVED NATURE OF LEARNING MOLE CONCEPT

Kenneth Adu-Gyamfi, Rejoice Elikem Vorsah
University of Cape Coast, Ghana
E-mail: kenneth.adu-gyamfi@ucc.edu.gh, vorsahrejoice024@gmail.com

Abstract

A good number of instructional strategies are identified to help students overcome their learning difficulties in the mole concept. However, Ghanaian senior high school students continue to have difficulties in the mole concept. Hence, there was the need to examine the perceived nature of learning the mole concept in the perspectives of male and female students. An explanatory sequential mixed methods design was adopted to collect quantitative and qualitative data. The students, selected through a multistage sampling procedure from four schools, responded to questionnaire and interview guide. Through independent-samples t-test statistics it was established that though students were full of uncertainty about the perceived nature of the mole concept that of males differed from their female counterparts. Hence, chemistry teachers should create learning environment conducive enough for male and female students to overcome their uncertainty in the mole concept.

Keywords: *chemistry teachers, gender variations, learning mole concept, perceived nature*

Introduction

The term molar, originated from the Latin word ‘moles’ meaning ‘a large mass’, was first introduced into chemistry by German chemist, August Wilhelm Hoffman around 1865. Thereafter, chemists adopted the mole concept as a more convenient way to deal with large mass of molecules or ions in a given sample (Ebbing & Gammon, 2017) and that the number of moles of atoms is the number of a modest size even less than one (Petrucci et al., 2017). This is because it was difficult for chemists to count directly the large amounts of particles at the microscopic level (Furio et al., 2002; Indriyanti & Barke, 2017). “A mole is the quantity of a given substance that contains as many molecules or formula units as the number of atoms in exactly 12g of carbon-12” (Ebbing & Gammon, 2017, p. 73). The mole concept is a conversion factor for a given problem-solving involving number of atoms, molar mass, Avogadro’s constant, , and percent abundance (Petrucci et al., 2017). Students have several questions to ask when dealing with the mole. One of such questions is: When do I multiply or divide using in calculations demanding Avogadro’s constant? (Petrucci et al., 2017).

This and other students’ questions bring to mind the issue of conceptual difficulties (Furio et al., 2002) in the form of alternative conceptions on mole concept. There are alternative conceptions students have about the mole concept and that when using the mole, it is advisable to specify the formula of the unit to prevent any misunderstanding (Ebbing & Gammon, 2017). Mulford and Robinson (2002) reported on students’ pre-concepts concerning the mole concept and concluded that students’ self-developed concepts do not match up with the scientific theories. The students came up with their own theory and logic through the observation in order to shape their ideas. For example, students mistakenly presumed the term mole as a value, whereas it is actually a quantity. This shows that those pre-concepts lead to the formation of

https://doi.org/10.33225/pec/22.80.09

alternative conceptions among the students, and students' scientific language is identified as a contributor to their alternative conceptions. There are difficulties in learning chemical concepts (Bilek et al., 2018; Goes et al., 2020), especially when the specific terminology and language are not differentiated (Barke et al., 2009).

These learning difficulties in chemical concepts could be addressed using an appropriate instructional approach, such as conceptual change approach (Calik et al., 2009; Ozmen, 2007). Because conceptual change approaches take students' prior or pre-existing knowledge into account (Calik et al., 2009), they help students overcome any alternative conception that students bring to classroom on chemical concepts (Ozmen, 2007). However, Mensah et al. (2016) reported that situational, cultural, and educational contexts affected their learning difficulties and conceptual change approaches of chemistry concepts. Hence, some research findings have emerged to examine the perceptions of students on another chemical concept in a Ghanaian context.

Students' minds are deeply grounded with the language they have acquired several years than the new scientific language, which has been picked up in recent lessons. Students feel insecure when using these scientific languages with friends or relatives. For instance, students resort to use the word "weight" instead of "mass" when describing a quantity in the mole concept. Students also think that the mole is a certain mass, a certain number of gas particles, and/or molecules. The mole principal value is a tool that indirectly counts atomic or molecular particles of substances by weighing macroscopic amounts of substances (Indriyanti & Barke, 2017). These alternative conceptions are sources of poor performances and perceptions about the mole concept.

The study by Hafsah et al. (2014) revealed that students with inadequate understanding of the mole concept performed poorly on stoichiometry problem-solving task and those with adequate understanding of the mole concept performed better on stoichiometry problem-solving tasks. This is because students' academic performance on stoichiometry correlates positively with their conceptual understanding of mole concept (Taha et al., 2014). Also, one of the pre-requisite chemical concepts that Bilek et al. (2018) found from literature to contribute to the complexity and multistage character of balancing chemical equations is the mole concept. According to Sarkodie and Adu-Gyamfi (2015), learning concepts at sub microscopic level are very difficult for students, and "the mole concept works on the sub-micro level of chemistry education than presented in macro and symbolic level" (Indriyanti & Barke, 2017, p. 5) and that could be the reason why students elsewhere expressed that mole concept is a difficult concept to understand (Voska & Heikkinen, 2000). Also, the poor mathematics ability, confusion, difficulties in remembering and manipulating the equations, no direct definition of the mole provided, and difficult to relate to real life (Moss & Pabari, 2016) account for the difficulties and perceptions students have in learning the mole concept.

Dahsah and Coll (2007) reviewed the achievements of 97 students from three secondary schools in Thailand, through standard questionnaire and reported that only 2.0% of the total respondents were able to comprehend all of the concepts including the mole. This means that students experience challenges in solving problems related to the mole concept by not being able to relate the mole to the number of particles, the mass of substance, and chemical equations. Another study by Kamaruddin et al. (2003) on 18 students of Chemical Education Degree programme noted that only 23.0% of the students understand chemistry concepts. And of the 23.0%, only 6.0% understand the concept of atoms, another 6.0%, the concept of molecules, and 11.0%, the concept of ions. For the mole concept and its relationship to chemical equations, students demonstrated very poor conceptual understanding (Furio et al., 2002).

In the United States, mole concept is often regarded as a difficult concept. This observation prevents students from continuing studies in the chemistry subject (Sirhan, 2007). This could be that students are faced with several challenges in dealing with abstract concepts like mole concept, requiring problem solving (Hafsah et al., 2014). In Nigeria, the mole concept is a concept students encounter challenges in learning for its high level of abstraction (Okebukola, 2005). Nigerian students, for many decades, performed very poorly on mole concept, involving mathematical and problem-solving skills in the Senior School Certificate Examination (SSCE) (Zephrinus & Phoebe, 2015). That is, students usually find it too tedious to connect the meaning of the mole concept. Hence, Calik et al. (2009) intervened on 18 male and 26 female students' conceptual understanding of solutions in a grade 9 class in Trabzon, Turkey using analogy activity as a conceptual change approach. Calik et al. reported that both male and female students constructed the scientific concepts of types of solution using the amount of substance dissolved in the solution.

In Ghana, the senior high school (SHS) chemistry curriculum has among its general aims to "produce, analyse, interpret, and evaluate qualitative and quantitative data; solve problems involving quantitative data …" and "make the subject interesting and motivating through designing hand-on activities for students to enhance their understanding of the subject" (Ministry of Education [MOE], 2010, pp. iv-v). These general aims are to introduce SHS students to the mole concept under carbon-12 scale, solutions, stoichiometry and chemical equations in year 1; and chemical equilibrium and acids and bases in year 2. Under these chemical concepts, students are to: recognise that the introduction of the carbon-12 scale was the beginning of the quantitative measurement of the amount of substance contained in different materials; demonstrate an understanding of the mole concept and its significance to the quantitative analysis of chemical reaction; demonstrate an understanding of qualitative and quantitative properties of solutions; understand that balanced chemical equations indicate the quantitative relationships between reactants and products involved in chemical changes (MOE, 2010, p. 11); explore acidic and basic solutions qualitatively and quantitatively; and use the principles and practice of titration to solve analytical problems (MOE, 2010, p. 33). Using school-based assessment on these chemical concepts, students are to go through laboratory and project works in the form of practical work, experiment, and investigative study (MOE, 2010) to achieve these objectives related to the mole concept.

The WAEC Chemistry Chief Examiner, assessing these and other objectives on behalf of the government and people of the Republic of Ghana, in 2015 elaborated on the lack of adequate knowledge of subject matter by candidates, lack of understanding of scientific terms in concepts of mole and their difficulty in answering questions that are based on comprehension (WAEC, 2015). The Chemistry Chief Examiner in 2016 further reported on candidates' poor mathematical skills exhibited in chemistry questions especially those on mole concept requiring calculations (WAEC, 2016). Also, in 2017 the Chief Examiner elaborated on candidates' inability to carry out simple calculations in chemistry particularly, the mole concept and mole related questions (WAEC, 2017). Though the Chemistry Chief Examiner has been hammering on students' poor performance in mole concept, no observable change has been realised in the advent of interventions on teaching and learning the concept in the SHS. On the basis of this, it was only imminent to examine the underlying cause of these difficulties in learning mole concept to help develop an alternative way of presenting it to students to enhance their academic achievement in the mole concept.

One of the research areas that can be considered in relation to learning the mole concept is the gender of students. Klinger and Findenig (2014) believed that from of old, there has always been some sort of debate on students' gender and learning of scientific concepts, with female students less likely to be on top (Doulík & Škoda, 2009). This is because gender stereotyping affects academic aspirations of students (Mburu & Nyagah, 2012). Hence, there was the need to examine the perceptions of students on the nature of learning the mole concept in relation to gender as male and female science students. Empirically, Shebu (2015) found that after using problem-solving approach on teaching mole concept, there was no difference in achievement of male and female students. Mukuta and Banda (2019) took care of the mathematics aspect of mole concept that various research has shown that it makes learning of the mole concept difficult to students. The incorporation of mathematics in teaching the mole concept positively influenced students' academic achievement and attitude, but there were no differences amongst male and female students. Damaso and Banda (2019) found that students' academic performance improved after teaching some aspects of the mole concept through the integration of concept mapping, but there was no difference in the academic performance of male and female students.

According to Furio et al. (2002), as students' difficulties exist in learning the mole concept, a number of research approach the problem looking at students' perception, but there continue to be disparity of viewpoints among chemistry educators and researchers. Hence, the need for another research using mixed methods design on students' perceptions of the mole concept cannot be over-emphasized. This is because almost every nation (including Ghana) is trying to achieve the SDG5, leading to the increased in the number of female students in schools in past 15 years, even in the area of science. The increased in the number of female students may have positively shaped their perceptions of learning the mole concept in the SHS in relation to their male counterparts. Hence, the aim of the current research was to examine whether the gender of the students can affect their perceptions of the nature of learning mole concept in the SHS. To achieve this aim, three research questions guided the research:

1. What is the perceived nature of learning the mole concept among SHS students?
2. How is the perception of male students on the nature of learning the mole concept in the SHS different from their female counterparts?
3. What instructional approaches do students suggest as ideal for teaching the mole concept to SHS students?

Research Methodology

Research Design

The research adopted sequential mixed methods approaches. Data were, therefore, collected from SHS students through explanatory sequential mixed methods. This mixed methods approach helped to merge quantitative and qualitative methods to examine the perceptions of students on nature of learning mole concept in relation to their gender, with greater stress quantitatively using the qualitative methods to help explain the perception. At the quantitative phase, data were collected from students through a cross-sectional survey. The students responded to a closed-ended questionnaire on the perceived nature of learning the mole concept in the SHS. The quantitative data were analysed to examine the perceived nature of learning the mole concept using means, standard deviations, percentages, and independent-samples *t*-test. The findings informed the researchers on the male and female students to participate in the qualitative phase and to shape some aspects of the interview guide. At the qualitative phase, based on the difference (if any) in the perceived nature of learning the mole concept, male and female students were selected for interviews on alternative ways of teaching the mole concept. The qualitative data were analysed using themes and percentages. Thereafter, the quantitative findings on the perceived nature of learning the mole concept were summarised and interpreted and the qualitative findings on the suggested alternative ways of teaching the mole concept were summarised and interpreted. Finally, the qualitative findings were used to explain the quantitative results.

Sample and Sampling Procedure

The Central Region was one of the 16 administrative regions of Ghana bordered by Ashanti and Eastern regions to the north, Western region to the west, Greater Accra to the east, and to the south by the Gulf of Guinea. The region was cosmopolitan with total population of 2,859,821 as the fourth most populous region in Ghana. It accounted for 9.3% of the total population of Ghana (Ghana Statistical Service, 2021). It was predominantly made up of the Akan tribe (90%). The Central Region was renowned for its many higher education institutions and an economy based on an abundance of industrial minerals and tourism. For this reason, the region was the hub of SHS education, with some of the best schools in the country that attracted students from all regions of the country. The region had three universities, five public nursing and midwifery training colleges, three colleges of education, and 76 public SHS. All the SHS in the region were some years back renowned for their outstanding performance in the West Africa Senior School Certificate Examinations, but at the moment the performance had dwindled a little bit.

Though there were 76 schools in Central Region, the researchers focused on only the 59 public SHS that offered students elective chemistry. The target population of the study, however, comprised all science students offering chemistry in the schools. The accessible population for the study was made up of all chemistry students in four schools. A multistage sampling procedure was used to select 300 SHS2 students (comprising 54.7% males and 45.3% females) from three district assemblies within the 22 metropolitan, municipal, and district assemblies. There were eight schools in the three districts. The eight schools were classified into two class A schools, two class B schools, three class C schools, and one class D school. One school each was simple randomly selected. In each school an intact class of SHS2 students was purposively selected to participate in the research. The corresponding number of students from schools A, B, C, and D were 60, 82, 68 and 90 students. Most of the 300 students (91.7%) were within the age bracket of 16-19 years, and 6.7% and 1.7% of the students were within the age bracket of 10-15 years and above 20 years respectively. Before data collection, we met with the selected students and briefed them on the purpose and the benefits of the research to the students and the country as a whole. The students demonstrated their willingness to participate in the research but requested that pseudonyms should be used to describe their schools and we (the researchers) promised to respect their decision.

Data Collection Instruments

One of the research instruments was a questionnaire, named; The Questionnaire on Student Knowledge and Perceptions of Mole [QSKPM] (Appendix A). QSKPM was structured on a 5-point Likert scale as 1 for strongly disagree, 2 for disagree, 3 for uncertainty, 4 for agree, and 5 for strongly agree. There were systematic and clear instructions for students on how they should respond to QSKPM. QSKPM had 21 items from which, Items 1- 2 were on general background information of students, Items 3- 20 on students' perceptions of the nature of learning mole concept, and Item 21 was an open-ended item that requested students to suggest some instructional approaches they considered to be most appropriate for teaching the mole concept. A confidentiality agreement was drafted and administered together with QSKPM to assure students of their privacy, anonymity, and confidentiality. QSKPM was constructed by the researchers based on literature, research, and teaching experiences. QSKPM was pilot tested with 40 students from two schools within the target population. The Cronbach's alpha reliability coefficient for QSKPM was calculated to be .80.

A semi-structured interview guide was the other research instrument employed in the research. It was In-Depth Interview Guide on Students' Knowledge of the Nature of Mole

[IDIGSKNM] (Appendix B). IDIGSKNM consisted of 10 items. That is, Items 1 - 6 were the main interview items before the lessons, Items 7- 9 were used after the lessons on mole concept, and Item 10 was on suggested instructional approaches for teaching mole concept. The content validity of IDIGSKNM was checked by two of our colleagues who were science educators. Internal validity of IDIGSKNM was ensured through credibility, where students had opportunities to clarify their earlier statements. The validity and reliability of IDIGSKNM were checked by recording of our interactions with students. Thereafter, trustworthiness of the interviews was ensured through the recordings of the interviews, which were transcribed, and students given the opportunities to compare the transcription to their views. Interviewer neutrality and consistent coding of the views of students on suggested instructional approaches for teaching the mole concept were used to further ensure the reliability of IDIGSKNM. The interviewers avoided asking too many questions to the students at a go. IDIGSKNM was pilot tested on three students from the target population in order to ensure reliability. Finally, we adopted credibility to ensure reliability of the interviews by engaging the students until the right responses obtained. The students were given enough time to organise their thought before responding to any question.

Data Collection Procedures and Analysis

After our interactions with the authorities of the schools, the confidentiality agreement was signed between the researchers and the students. In the second week of data collection, QSKPM was given to students, and they responded to it individually. Students responded to QSKPM within 60 minutes and returned them to the researchers. This took us a week as we spend a day in each school for the QSKPM administration. Thereafter, the data from QSKPM were analysed to establish students' perceptions of the nature of learning the mole concept among the male and female students. Based on the results from the analysis of the data from QSKPM, 10 students each from each school were identified for the focus group interviews using IDIGSKNM. That is, there were five males and five females from each school. Hence, a total of 40 students took part in the focus group interviews. However, each of the 300 students was given the opportunity to write his or her views on Item 21 on QSKPM (*in your view, how should the mole concept be taught to senior high school students?*) and later on Item 10 on IDIGSKNM (*If another teacher is going to teach you this topic next time, what should be the best way of teaching it?*) before sharing with the groups in the interviews. The written views of students were later collected to help in comparing the recorded interactions. Students' views on how best the mole concept should have been taught in the SHS are being reported here.

The aim of the research was investigated in three parts: examining the perceived nature of learning the mole concept, examining the differences in the perceived nature of learning the mole concept among male and female students, and examining the perceived suggested instructional approaches to learning the mole concept. Percentages, means, and standard deviations were used to examine the perceived nature of learning the mole concept. From the 5-point Likert scale, a mean of 5.0 – 3.5 indicated Agree (that is, positive perception), 3.4-2.5 was Uncertainty (that is, neutral perception), and 2.4-1.0 was Disagree (that is, negative perception). The independent-samples *t*-test was used to examine any differences in the perceived nature of learning the mole concept among male and female students. Finally, the recorded interviews were transcribed in the course of data processing. The transcribed data were open-coded and constantly compared to the established themes. Sample statements from which the themes were formed were used as supporting statements.

Research Results

Perceived Nature of Learning the Mole Concept

Research Question 1 sought to examine the perceptions of students on learning the mole concept. To be able to achieve this, Items 3-20 on QSKPM were used. The mean scores on students' perceptions on the mole concept are presented in Table 1.

Table 1
Students' Perceptions on Mole Concept (N = 300)

Item	Agree		Disagree		Uncertain		*M*	*SD*
	n	*%*	*n*	*%*	*n*	*%*		
3	250	83.3	37	12.3	13	4.3	4.0	1.06
4	195	65.0	85	28.3	20	6.7	2.5	1.44
5	130	43.3	152	50.7	18	6.0	3.1	1.35
6	234	78.0	43	14.3	23	7.7	2.1	1.07
7	123	41.0	152	50.7	25	8.3	3.2	1.38
8	170	56.6	114	38.0	16	5.3	2.7	1.46
9	124	41.3	161	53.7	15	5.0	3.2	1.42
10	184	61.3	85	28.3	31	10.3	2.6	1.31
11	252	84.0	36	12.0	12	4.0	1.9	1.09
12	141	47.0	143	47.7	16	5.3	3.0	1.45
13	117	39.0	157	52.4	26	8.7	3.2	1.40
14	78	26.0	211	70.3	11	3.7	3.7	1.42
15	150	50.0	129	43.0	21	7.0	2.9	1.37
16	92	30.6	157	55.7	41	13.7	3.3	1.28
17	96	32.0	171	57.0	33	11.0	3.4	1.37
18	76	25.3	208	69.3	16	5.3	3.6	1.39
19	84	28.0	201	67.0	15	5.0	3.6	1.42
20	255	85.0	37	12.3	8	2.7	4.3	1.18
Overall mean							3.1	1.33

Note: Where *N* = the total number of students who participated in the study; *n* = the total number of students who were uncertain, agreed, or disagreed to each item; *M* = the perceived mean score; *SD* = Standard deviation

On students' perceptions on teaching and learning of the mole concept in the SHS, three perspectives can be seen from the results in Table 1. That is, there were statements on the mole concept that students agreed to, and others, they disagreed to, or were uncertain on. On Item 20, of the 300 students 85.0% with highest mean of 4.3 (*SD*= 1.18) agreed that the mole concept can be understood better if teachers teach with teaching and learning materials (resources). This gave an indication that 15.0% of the students were uncertain or disagreed to the statement. Hence, students perceived that mole concept can be understood better if teachers teach with teaching and learning resources. On Item 3, large number of students (83.3%) with a high mean of 4.0 (*SD*= 1.06) agreed that mole concept is easy and interesting. This showed that 16.6% of the students were uncertain or disagreed to the statement. Hence, majority of students perceived that mole concept is easy and interesting to learn. On Item 14, very few (26.0%) students with a mean of 3.7 (*SD* = 1.42) agreed that teachers did not teach balancing of chemical equations and reactions before the mole concept. This indicated that 70.3% of the students disagreed to the statement. Hence, few of the students perceived that their difficulties in learning mole concept are because they did not learn balancing of chemical equations prior to learning the mole concept. On Item 18, of the 300 students, 25.3% with a mean of 3.6 (*SD* = 1.39) agreed that the mole concept is the only concept they fail to understand, no matter how hard they try. This indicated that 69.3% of the students disagreed to the statement. Hence, few of the students perceived they could not understand the mole concept even if they try harder to make meaning of. On Item 19, of the 300 students, 28.0% with a mean of 3.6 (*SD* = 1.42) agreed that they did not show much interest in learning mole concept because they did not like it. This indicated that 67.0% disagreed to the statement. Hence, few of the students perceived to have low interest in mole concept.

The second perspective of the results from Table 1 was where students disagreed with some of the statements on the nature of learning the mole concept. The results showed that on Item 11, of the 300 students, only 12.0% with the lowest mean of 1.9 (*SD* = 1.09) disagreed that mole concept requires enough mathematical background knowledge. This gave an indication that 84.0% of the students agreed to the statement. Hence, few of the students perceived that mole concept requires not enough mathematical background knowledge to enhance their conceptual understanding on the mole concept. On Item 6, of the 300 students, 14.3% with a low mean of 2.1 (*SD* = 1.07) disagreed that the concept of mole entails a lot including the use of Avogadro’s number and amount of substance in 12g of crabon-12. This *gave* an indication that 78.0% of the students agreed to the statement. Hence, few of the students perceived that learning of mole concept does not entail a lot.

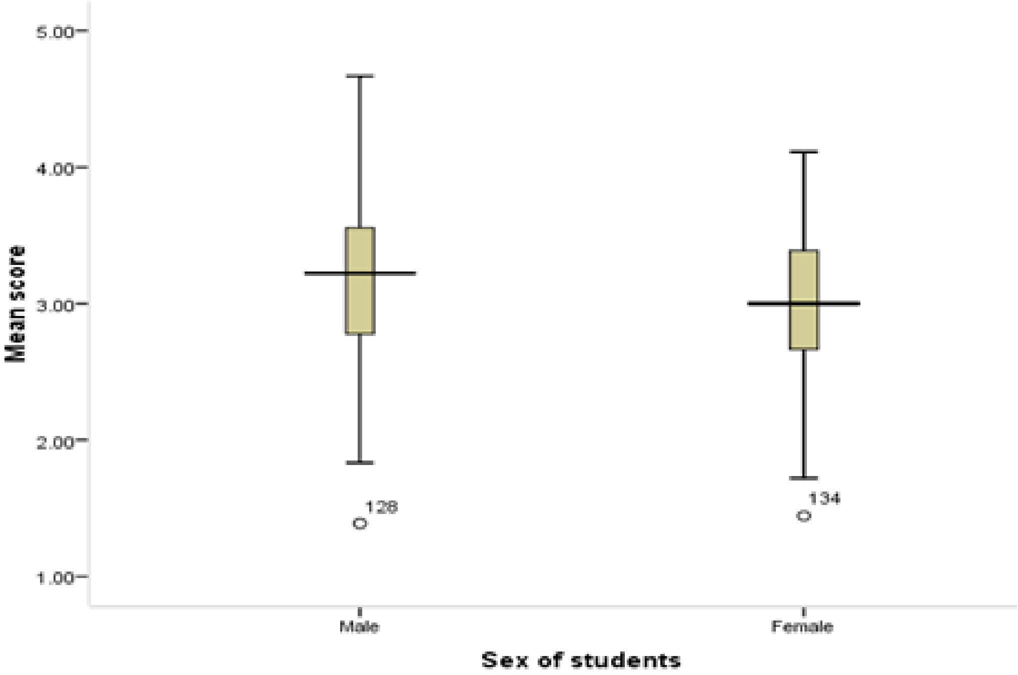
The third perspective to the results from Table 1 was revealing as students were uncertain on 11 items on QSKPM. On Item 17, 11.0% of the students with a mean of 3.4 (*SD* = 1.37) failed to agree or disagree that the mole concept is a concept which had to do with only molecules and not atoms. This indicated that 32.0% students agreed, and 57.0% students disagreed to the statement. Hence, the students were not sure of mole concept being about only molecules, but not atoms. On Item16, of the 300 students, 13.7% with a mean of 3.3 (*SD* = 1.28) failed to agree or disagree that they most of the time considered mole as a mass and did not use the concept as the unit of amount of substance. This indicated that 30.6% students agreed and 55.7% disagreed to the statement. Hence, the students were not sure they considered mole as a mass and not the unit of amount of substance. On Item 7, 8.3% of the students with a mean 3.2 (*SD* = 1.38) failed to agree or disagree that they preferred rote learning of the mole concept because it was too difficult. This indicated that 41.0% students agreed, and 50.7% students disagreed to the statement. Hence, the students were unsure that they preferred rote learning of mole concept because it was too difficult to understand. On Item 13, 8.7% of the students with a mean of 3.2 (*SD* = 1.40) failed to agree or disagree that they had no previous knowledge relating to mole concept and found the mole concept so strange to understand. This indicated that 39.0% students agreed, and 52.4% students disagreed to the statement. Hence, the students were unsure having previous knowledge in the mole concept and found the concept so strange to understand. On Item 9, 5.0% of the students with a mean of 3.2 (SD = 1.42) failed to agree or disagree that they spent more time in learning mole concept than other concepts in chemistry. This indicated that 41.3% students agreed, and 53.7% students disagreed to the statement. Hence, students were unsure whether they spent more time in learning the mole concept than other chemical concepts. On Item 5, 6.0% of the students with a mean of 3.1 (*SD* = 1.35) failed to agree or disagree that chemical names and terms in mole concept were too complex for them to understand. This indicated that 43.3% students agreed, and 50.7% students disagreed to the statement. Hence, the students were unsure that the chemical names and terms in mole concept were too complex for them to understand. On Item 12, of the 300 students, 5.3% with a mean of 3.0 (*SD* = 1.45) were uncertain that they did not master the skills of solving certain mathematical problems before learning mole concept and that they solved questions on mole concept through memorisation. This indicated that 47.0% students agreed, and 47.7% students disagreed to the statement. Hence, the students were unsure that they did not master the skills of solving certain mathematical problems before learning the mole concept. On Item 15, of the 300 students, 7.0% with a mean of 2.9 (*SD* = 1.37) failed to agree or disagree that their knowledge in atomic structure was minimal before learning the mole concept. This indicated that one-half of the students agreed and 43.0% students disagreed to the statement. Hence, the students were unsure that their knowledge in atomic structure was minimal prior to learning the mole concept. On Item 8, 5.3% of the students with a mean of 2.7 (*SD* = 1.46) failed to agree or disagree that the mole concept was too theoretical. This indicates 56.6% students agreed and 38.0% students disagreed to the statement. Hence, the students were unsure that the mole concept was theoretical to learn. On Item 10, of the 300 students, 10.3% with a mean of 2.6 (*SD* = 1.31) failed to agree or disagree that mole concept was quite technical. This indicated that 61.3% students agreed, and 28.3% students disagreed to the statement. Hence, the students were unsure that mole concept was quite technical. On Item 4, 6.7% of the 300 students with a moderate mean of 2.5 (*SD* = 1.44) failed to agree or disagree that mole concept was boring when taught using inadequate teaching approaches. This gave an indication that 65.0% students agreed, and 28.3% students disagreed to the statement. Hence, the students were uncertain that mole concept could only be boring when teachers adopted inadequate teaching approaches in teaching.

In all, the results in Table 1 showed that the overall mean of 3.1 (*SD* = 1.33) was obtained on the perception of students about the nature of learning the mole concept. This indicated that students had uncertain perception about the mole concept and that their perception was neither positive nor negative, but neutral. The findings from Table 1 show that most of the students were uncertain about the nature of the mole concept. This means that students involved in the study could not perceive the nature of the mole concept in a similar way. However, the findings from Table 1 could not bring forth the perceptions of male and female students on the nature of learning the mole concept even if there were indication of uncertainty among them.

Differences in the Perceived Nature of Learning the Mole among Male and Female Students

Research Question 2 sought to examine whether male and female students involved in this study perceived the nature of learning the mole concept differently. A boxplot was, therefore, used to explore the perceptions of male and female students on the nature of mole concept. The results of the boxplot exploration are presented in Figure 1.

Figure 1
A Boxplot of Male and Female Students' Perception of the Nature of the Mole Concept



From Figure 1, the results showed there was an overlap in the mean scores of male and female students on the nature of learning the mole concept. This was because the interquartile range of male students was 14.0 and that of female students, 13.0. The results showed that at the mid 50.0%, male students' perceptions on the nature of mole concept were higher than the female students. This could be due to the percentage of male students involved in the study being higher to that of the females. Though the mean scores confirmed the revelation that students were uncertain about most of the statements, but the mean score of male students' perception of the nature of mole concept (*M* = 57.1, *SD* = 10.02) was higher than the mean score of female students' perception of the nature of mole concept (*M* = 54.3, *SD* = 9.20). Since the boxplot could not establish the statistical difference in perceptions of male and female students on the nature of the mole concept, there was the need to use the independent-samples *t*-test.

The independent-samples *t*-test was used because, first, when the normality of the distribution of the perceived scores on nature of learning the mole concept was tested using the Kolmogorov-Smirnov statistic, it was found to be normally distributed. This was because the calculated significance of the Kolmogorov-Smirnov statistic was more than .05 (that is, *p* = .200). Also, when the homogeneity of variance assumption was checked using Levene's test, it was not significant (*p* = .324). This meant that the variances for the male and female students were the same and that the assumption has not been violated. Hence, the *t*-test values of equal variance assumed will be reported here. The results of the independent-samples *t*-test statistics were used to test whether there was a statistically significant difference in the perceptions of male and female students on the nature of the mole concept. The results on the independent-samples *t*-test are presented in Table 2.

Table 2
Results on Difference between Male and Female Students' Perceptions on Nature of Mole Concept

Gender	*N*	*M*	*SD*	*t*	*df*	*p*
Male	164	57.1	10.02	2.541	298	.012*
Female	136	54.3	9.20			

Note: * Significant, $p < .05$

The results from Table 2 showed that there was a statistically significant difference between the mean perception score of male students and the mean perception score of female students on the nature of learning the mole concept. This was because mean perception score of male students ($M = 57.1$, $SD = 10.02$) was higher to the mean perception score of female students ($M = 54.3$, $SD = 9.20$, $t\ (298) = 2.541$, $p = .012$) on nature of learning the mole concept. This meant that most of the male students were uncertain about the nature of learning the mole concept as compared to female students. A calculated effect size (eta squared = .021) indicated that only 2.1% of the variance in the perceived nature of learning the mole concept was explained by the gender of the students. This magnitude of the differences was small.

Suggested Instructional Approaches for Teaching the Mole Concept to SHS Students

With respect to the views of students on instructional approaches that could be ideal to teaching the mole concept, students' responses on Item 21 on QSKPM and Item 10 in IDIGSKNM were examined. The results on the frequencies and percentages on alternative ways of teaching mole are presented in Table 3.

Table 3
Percentages of Students' Views on Suggested Ways of Teaching Mole Concept to Students (N = 300)

Suggested ways	*n*	%
Mole concept should be taught by practical means using adequate teaching and learning resources like images, models, concept cartoons, and videos	186	62.0
Mole should be taught both theoretically and practically	14	4.7
Mole concept should be taught by first teaching students to have mastery in mathematics, chemical equation, chemical bonding, atom and other related concepts before the mole concept	69	23.0
Mole concept should be taught with appropriate technique to enhance students' understanding of the mole concept	11	3.7
Mole concept should be taught by teachers solving enough calculations questions with students and give them more examples to solve on their own	14	4.7
The mole concept should be taught using the local language and simplified the terminologies in mole concept	3	1.0
Teaching the mole concept by well experienced chemistry teachers at the senior high school	3	1.0

From Table 3, 62.0% of the students suggested that the teaching of the mole concept should be practical-oriented. The practical lessons should be achieved by using teaching and learning resources such as, audio-visuals, models, concept cartoons, and real laboratory apparatus. One of the students suggested practical lessons as;

> *Making lesson practical, will make us to be actively involved in the lesson or it will make the mole concept lesson student friendly one* (School A, female student).

Another student from School A explained that;

> *... we were only listening to the teacher, and this makes the lesson look as if our teacher is the one learning, but we are. Our teacher did not use adequate teaching resources. From the look of things practical work will help us in learning the mole better* (School A, male student).

Some of the students explained that the practical should not always be laboratory-based but can be taken as part of classroom lessons on the mole concept. This is because not all aspects of the mole concept need laboratory work for students to understand. A student from School C explained that;

> *I think practical lessons could help students to understand. If there are no sufficient materials, it can be demonstrated in our classroom ...* (School C, female student).

Some of the students expressed some concerns about practical lessons as though important for teaching chemistry, but new ways of teaching are needed. The students perceived teachers who are experts in teaching chemistry can design their teaching using models and concept cartoons. One of the students explained that;

> "*... though we all call for practical works, but I think experts in teaching chemistry should come out with alternative way of teaching mole concept using what they call cartoons where the real objects are not there ... I think the expert teachers can do that* (School B, male student).

From Table 3, some of the students (23.0%) mentioned that the mole concept should be taught by first teaching students to have mastery in mathematics, chemical equation, chemical bonding, atom and other related concepts before the mole concept. Sample students' views were;

> *I suggest teachers teach us the background knowledge relating to the mole concept and so, we find the concept to be less difficult* (School A, female student).
> *As the mole concept involves mathematics, I would like to have control over mathematics, so my teachers should teach the mathematics first* (School C, male student).
> *I think our teachers should teach us any knowledge that will help us to understand mole concept first* (School D, male student).

Furthermore, of the 300 students, 4.7% recommended that the mole concept should be taught by teachers solving enough calculation questions with students and thereafter, give them more examples to solve on their own. One of the students explained that;

> *Worked examples will help me to understand mole concept. So, I suggest our teachers teach us how to do calculations under mole and follow it up with more examples* (School D, female student).

Also, 4.7% of the students explained that teachers should teach mole through theoretical and practical means. This approach, students think would help them understand the mole concept better. One of the students explained that;

> *I think the teachers should be not one-sided. Both the theory and practical are needed and teachers should use the practical to help us understand the theory* (School A, male student).

In another instance, 3.7% of the students explained that teachers should select and use the most appropriate instructional strategies to the teaching of the mole concept. That is, when the most appropriate instructional strategies are used by teachers, it will help students to develop the right conceptual understanding of the mole. For example;

> *I don't know any best way, but our teachers do. They should use the right method of teaching to teach us* (School B, male student).

Though not popular among students, but 1.0% of the students explained that mole concept should be taught by teachers using local language and simple terminologies. For example,

> *I think our teachers should use the local language to make the terminologies easier for us* (School B, female student).

From Table 3, another 1.0% of the students explained that the mole concept should be taught by well-experienced chemistry teachers in the SHS. The reason was that well-experienced teachers have enough skills and knowledge to teach the mole concept better. One of the students explained that;

> *Let experience teachers teach us. Experience teachers have the experience to help students to understand the mole concept* (School C, female student).

Discussion

Findings on perceptions of students on nature of the mole concept show that the students involved in the research can improve their conceptual understanding on the mole if teachers select and use the right teaching and learning resources in teaching the concept. This is no surprise as it has been proven in a lot of research (such as Adu-Gyamfi et al., 2020) that the use of teaching and learning resources help teachers to engage students in participatory learning to help them improve their conceptual understanding of chemical concepts. Another instance where students involved in the study share common perception is mathematical knowledge which is a pre-requisite to understanding the mole concept. Though students perceive that they could do well on the mole concept even if they do not have enough mathematical knowledge. Students not perceiving that the knowledge of mathematics is an important pre-requisite to learning the mole concept could partly be the reason for their difficulties in answering the mole concept-related question in the examinations conducted by WAEC. However, chemistry students in the SHS should have the needed knowledge in mathematics because all students offering General Science, with chemistry as one of the subjects, also offer Elective-mathematics to enrich their mathematical capabilities, unlike the results of Moss and Pabari (2016) and Mweshi et al. (2019). If mole concept is easy and interesting to learn, then it should attract students and they should have positive perception, but not neutral. Chemistry teachers are therefore encouraged to look for more opportunities with which they can make mole concept more interesting and easier to learn as Rollnick et al. (2008) reported that a lot of research has looked at making teaching and learning of chemistry interesting to both teacher and student.

However, with respect to depth of the mole concept, students are in agreement of the perceived nature of mole concept with that of their teachers. As students appreciate that mole concept does not entail a lot, teachers (in another research) see it as a brief concept involving Avogadro's number and the amount of substance in 12g of carbon-12. This could imply that teachers who are full of uncertainty in the perceived nature of mole concept (Vorsah & Adu-Gyamfi, 2021) cannot help students overcome their learning difficulties as students are who they are in relation to what their teachers offer them. The finding that students look forward to see teachers use adequate instructional approaches and that they select the most appropriate in the teaching mole concept is significant as the concept seems difficult to students and they should be helped to overcome the difficulty. Indeed, when the right instructional strategies are not selected for teaching, students even end up developing alternative conceptions making the mole concept difficult. Hence, in this research, students' perceptions of mole concept are linked to the selection and usage of instructional strategies and teaching and learning resources. Though students are interested in learning the mole concept, their interest could in some ways be affected by the selection and usage of inappropriate instructional strategies. Chemistry teachers are, therefore, encouraged to continually select and use the most appropriate instructional strategies, such as participatory teaching and learning approach (Adu-Gyamfi et al., 2020), computer simulation games (Bilek et al., 2018), conceptual change approach (Calik et al., 2009; Priede & Krumina, 2012), learning cycle (7E model) (Santi & Atun, 2020), and cooperative learning approach (Avci et al., 2019) for teaching the mole concept to attract students to it. The nature of the mole concept, which entails abstractness and mathematics, could influence the concept by resulting in the difficulties encountered in the teaching and learning (Chong et al., 2019; Mweshi et al., 2019) and these, students in this research appreciate. Another finding shows that students feel they have the abilities to understand the mole concept like other chemical concept. If students have the abilities, to learn mole concept, then they should not have difficulties in it at all. And if there are difficulties in students' learning of the mole concept, then the issue could be that students are not getting the right instruction as well as instructional resources to facilitate learning. If students are confident of learning the mole concept and are prepared to put in much effort, then teachers should look for the most appropriate means of helping students to learn the mole concept. The finding that students' difficulties in learning the mole concept are because they did not learn balancing chemical equations prior to learning mole concept confirms the work of Jecelle et al. (2017) where students felt short in stoichiometry (an aspect of the mole concept) because of weaknesses in balancing chemical equations, but disconfirms the report of Bilek et al. (2018) from the literature that the mole concept is perceived to be pre-requisite for learning balancing of chemical equations. This means there is uncertainty in pre-requisite concepts to learning the mole concept and that most of the pre-requisite concepts to help students conceptualise the mole concept should be attained, and their difficulties could be related to the absence of these pre-requisite concepts. The findings show that there is a lot of uncertainty in perceptions of students on the nature of mole concept. This could be that the teachers teaching this mole concept in Ghanaian SHS are full of uncertainty in the concept (Vorsah & Adu-Gyamfi, 2021). These findings could serve as the factors contributing to students' difficulties in learning mole concept. This is because in one breath, students are not sure of any particular aspect of the mole concept and in another, students are uncertain about considering the mole as a mass, but not the unit of amount of substance, or preferring rote learning of mole concept as it is a difficult one. This could also be that teachers' instructional strategies used in teaching mole concept have not challenged students enough to confront their alternative conceptions in the mole concept. These instances of students' uncertainty about the perceived nature of mole concept could account for students' difficulties in learning the concept. Students are further indecisive that they spend more time in learning the mole concept than other concepts in chemistry. This could be that most students do not have any knowledge of all the aspects of the concept of mole in the SHS curriculum and that teachers need more time to complete or rush to finish lessons within a short period of time. Students in the same way are uncertain whether they need enough time to understand the concept taught by teachers. Unless they prefer to learn by rote, which takes little time to accomplish learning the mole concept, then they will need more time to learn. Hence, students are uncertain that the chemical names, calculations, and terms in mole concept are too complex for their understanding. This could be that most students for the time being have only been introduced to basic concepts such as mole, concentration, and molar mass, which may not require complex chemical names, calculations, stoichiometry, and other terms. It is worthy of note that students' uncertainty about the mole concept is not good enough for chemistry education and could affect their subsequent learning (Driver, 1989; Gilbert et al., 1982; Johnstone, 1991) and misunderstanding on the mole (Taha et al., 2014). Students' perceptions of previous knowledge relating to the mole concept is another area of uncertainty. If students are uncertain about having related previous knowledge to the mole concept, then it will be difficult to construct new knowledge from any information on the mole concept from previous understanding (Lefa, 2014). It is not surprising that students are displaying their little conceptual knowledge in mole concept, by perceiving mole concept as a concept, which had to do with only molecules and not atoms. This is the evidence of students' ignorance about conceptual knowledge on the mole concept and the development of their perception from their lack of conceptual knowledge about pre-requisite concepts (Treagust et al., 2000; Tsoi et al., 1998). Nonetheless, this prior concept is the key factor in understanding chemical concepts, and teachers expect students to possess it before learning the mole concept.

There is a statistically significant difference between male and female students on the perceived nature of learning the mole concept, which is full of uncertainty. In other words, the gender of students influences the kind of perception students have about the mole concept. Though the magnitude of the differences is small, the current research brings to light that the perceived nature of learning the mole concept being biased by the gender of the SHS students cannot be ignored. Also, male students are more uncertain in their perceptions about the mole concept compared to their female counterparts. This finding has added to Majere et al. (2017) study, which shows a statistically significant difference between male and female students' perceptions and reflections on academic achievement of chemical concepts. Also, it may stem from poor mathematical background that affects students' learning of chemical concepts (Moss & Pabari, 2016). Hence, such a difficulty may have resulted in a statistically non-significant difference in students' perceptions and academic achievements on the mole concept (Mukuta & Banda, 2019).

There are several perceived ways of teaching mole concept for students to understand. Some of these ways include the use of models, concept cartoons, multimedia, videos, and mastery learning instructional strategy. The rest are inquiry-based activities, inductive teaching method, and learning cycles. The findings show that students suggest that the teaching of the mole concept should be practical. The practical lessons could be achieved using teaching and learning resources that are ICT-based or not. Examples such as computers, animations, models, and real apparatus are assumed to help facilitate teaching and learning. These teaching and learning resources would enhance the effective understanding of the concept by students (Ajayi & Ogbeba, 2017). There is, therefore, the need for curriculum developers to recommend the most appropriate instructional strategies with teaching and learning resources that will help chemistry teachers facilitate the teaching of the mole concept within the practical approaches. Though not popular, students suggest the use of local language in teaching mole concepts. This could be that language is not a barrier to learning the mole concept as reported elsewhere (Suchting, 1998) or the language they have acquired over the years (Indriyanti & Barke, 2017) could be affecting their perception of learning the mole concept. It is, therefore, necessary for chemistry educators and researchers to look at the issues of language and learning of chemical concepts once again. It could be that the scientific language is the challenge (Barke et al., 2009; Wertsch, 2000), but not the use of local language in teaching chemical concepts. The Ministry of Education through the National Council for Curriculum and Assessment should, therefore, reconsider any intent of using the local language in teaching science-related subjects such as chemistry in the SHS in Ghana. Strong background knowledge and experiences in mathematical and other chemical concepts relating to the mole are perceived to help students develop the correct conceptual understanding in the concept. Students, therefore, suggest that one other best way of teaching the mole concept is having previous knowledge and experiences in mathematics, chemical equations, and chemical bonding. If students have suggested that one other best way of teaching the mole concept is taking care of previous experience, then chemistry educators should take advantage of that (Lefa, 2014) to help students. The uncertainty among students becomes evident here as they perceive that mathematical knowledge is not a pre-requisite for learning the mole concept but suggest that teachers should help them to attain mastery in mathematics to aid in knowledge construction of the mole concept. There is, therefore, the need for chemistry educators and researchers to further investigate the place of mathematical knowledge in influencing the perceptions and conceptual understanding of senior high school students on the mole concept.

Conclusions and Implications

The study has shown that there are a lot of instances where both male and female students are uncertain about the nature of learning the mole concept. For example, students are uncertain of their preference for rote learning of the mole concept as a difficult concept. Notwithstanding, the students' uncertainty in the perceived nature of learning the mole concept, the current study has added to the literature that students are in agreement of uncertainty with their teachers that the mole concept is a shallow area in chemistry, but it is a broad one that entails a lot, not just Avogadro's number and the amount of substance in 12g of carbon-12. The Ministry of Education through the Ghana Education Service should organise teacher professional development programmes where chemistry educators will engage teachers in teaching chemistry in SHS to the true depth of the mole concept in the SHS curriculum to stimulate students' perceptions. In all, male students are more uncertain in the nature of learning the mole concept compared to their female counterparts. However, both male and female students have interest in learning chemical concepts. This is evident by the fact that students perceived mole concept as an easy and interesting area in chemistry. Though mole concept is abstract and mathematical, students have confidence learning the concept. The study has once again added to the literature on chemistry education that students see mole concept as easy and interesting chemistry notwithstanding their difficulties in examination items on the concept. Though students are uncertain, but male students are most uncertain on the nature of learning the mole concept compared to their female counterparts, hence, teachers teaching chemistry in the SHS should create an environment conducive to male and female students to overcome their uncertainty on the perceived nature of learning the mole concept. Also, curriculum developers should recommend cooperative and participatory teaching-learning approaches that consider male and female students' difference for teaching chemistry in the SHS.

Declaration of Interest

The authors declare no competing interest.

References

Adu-Gyamfi, K., Ampiah, J. G., & Agyei, D. D. (2020). Participatory teaching and learning approach. A framework for teaching redox reactions at high school level. *International Journal of Education and Practice, 8*(1), 106-120. https://doi.org/10.18488/journal.61.2020.81.106.120

Ajayi, V. O., & Ogbeba, J. (2017). Effect of gender on senior secondary chemistry students' achievement in stoichiometry using hands-on activities. *American Journal of Educational Research*, *5*(8), 839-842. http://dx.doi.org/10.12691/education-5-8-1

Avci, F., Kirbasiar, F. G., & Sesen, B. A, (2019). Instructional curriculum based on cooperative learning related to the structure of matter and its properties: Learning achievement, motivation and attitude. *South African Journal of Education, 39*(3), 1-14. https://files.eric.ed.gov/fulltext/EJ1228981.pdf

Barke, H. D., Hazari, A., & Yitbarek, S. (2009). Students' misconceptions and how to overcome them. In *Misconceptions in Chemistry* (pp. 21-36). Springer.

Bilek, M., Nodzynska, M., Kopek-Putala, W., & Zimak-Piekarczyk, P. (2018). Balancing chemical equations using sandwich making computer simulation games as a supporting teaching method. *Problems of Education in the 21st Century, 76*(6), 779-799. https://dx.doi.org/10.33225/pec/18.76.779

Calik, M., Ayas, A., & Coll, R. K. (2009). Investigating the effectiveness of an analogy activity in improving students' conceptual change for solution chemistry concepts. *International Journal of Science and Mathematics Education, 7,* 651-676. https://doi.org/10.1007/s10763-008-9136-9

Chong, S. H., Goolamally, N., & Leong, K. E. (2019). Post-Secondary science students' understanding on mole concept and solution concentration. *Universal Journal of Educational Research*, *7*(4), 986-1000. http://dx.doi.org/10.13189/ujer.2019.070410

Dahsah, C. & Coll, R. K. (2007). Thai grade 10 and 11 students‟ conceptual understanding and problem-solving ability in stoichiometry. *Research in Science and Technology Education*, *25*, 227-241. https://doi.org/10.1080/02635140701250808

Damaso, K., & Banda, A. (2019). Effect of concept mapping on learner achievement on mole concept. *International Journal of Advanced Research and Publications, 3*(11), 18-26.

Doulík, P., & Škoda, J. (2009). Challenges of contemporary science education. *Problems of Education in the 21st Century, 11*, 45-50. http://www.scientiasocialis.lt/pec/node/208

Driver, R. (1989). Students' conceptions and the learning of science. *International Journal of Science Education*, *11*(5), 481-490. https://doi.org/10.1080/0950069890110501

Ebbing, D. D., & Gammon, S. D. (2017). *General chemistry* (11th ed.). Cengage Learning EMEA.

Furio, C., Azcona, R., & Guisasola, J. (2002). The learning and teaching of the concepts 'amount of substance' and 'mole': A review of literature. *Chemistry Education: Research and Practice in Europe, 3*(3), 277-292.

Ghana Statistical Service. (2021). *2021 population and housing census. Press release on provisional results.* Author. https://statsghana.gov.gh/gssmain/storage/img/infobank/2021%20PHC%20Provisional%20Results%20Press%20Release.pdf

Gilbert, J., Osborne, R. J., & Fensham, P. J. (1982). Children's science and its consequences for teaching. *Journal of Science Education, 66*(4), 623-633. https://doi.org/10.1002/sce.3730660412

Goes, L. F., Nogueira, K. S. C., & Fernandez, C. (2020). Limitations of teaching and learning redox reactions: A systematic review. *Problems of Education in the 21st Century, 78*(5), 698-718. https://doi.org/10.33225/pec/20.78.698

Hafsah, T., Rosnani, H., Zurida, I., Kamaruzaman, J., & Yin, K. Y. (2014). The influence of students' concept of mole, problem representation ability and mathematical ability on stoichiometry problem solving. *Scottish Journal of Arts, Social Sciences and Scientific Studies*, *3*, 28-99.

Indriyanti, N. Y., & Barke, H.-D. (2017). Teaching the mole concept with sub-micro level: Do the students perform better? In: *AIP Conference Proceedings 1868*, 030002 (2017). https://doi.org/10.1063/1.4995101

Jecelle, A. Jaranilla, Maricar, S., Prudente, & Perez, D. R. (2017). Exploring students' conceptions on stoichiometry using SCQS and VCQS. *Asia Pacific Journal of Education, Arts & Sciences, 4*(2), 45-51.

Johnstone, A. H. (1991). Why is science difficult to learn? Things are seldom what they seem. *Journal of Computer Assisted Learning*, *7*(2), 75-83. https://doi.org/10.1111/j.1365-2729.1991.tb00230.x

Kamaruddin, M. I., Ambrose, M. S., & Ling, H. L. (2003). *The mastery of chemistry and its relationship with the solution of the mole concept problem: A case study among second year students of chemistry education at Faculty education*. University Technology Malaysia. http://eprints.utm.my/2338/112.Meor.pdf

Klinger, S., & Findenig, I. (2014). Making gender a subject of discussion – A mission (IM) possible in the 21st century?! Students of educational studies as an example within the context of academia. *Problems of Education in the 21st Century, 60,* 101-113. https://dx.doi.org/10.33225/pec/14.60.101

Lefa, B. (2014). The Piaget theory of cognitive development: An educational implication. *Journal of Educational Psychology*, *1*(1), 1-8.

Majere, I. S. M., Role, E., & Makewa, L. N. (2017). Gender Disparities in self-concept, attitude and perception in physics and chemistry. *Atlas Journal of Science Education*, *2*(1), 61-69. http://dx.doi.org/10.5147/ajse.v2i1.77

Mburu, D. N. P., & Nyagah, G. (2012). Effects of gender role portrayal in textbooks in Kenyan primary schools, on pupils' academic aspirations. *Problems of Education in the 21st Century, 47,* 100-109. https://dx.doi.org/10.33225/pec/12.47.100

Mensah, A., Morabe, O. N., & Golightly, A. (2016, October 23-28). *Teaching chemical equilibrium through conceptual change approach: A synthesis and analysis of the literature*. A paper presented at ISTE International Conference on Mathematics, Science and Technology Education, Mopani Camp, Kruger National Park, Limpopo, South Africa.

Ministry of Education. (2010). *Teaching syllabus for chemistry (senior high school 1-3).* Author.

Moss, K., & Pabari, A. (2016). The mole misunderstood. *New Directions in the Teaching of Physical Sciences*, *6*, 77-86. https://doi.org/10.29311/ndtps.v0i6.392

Mukuta, M., & Banda, A. (2019). The effect of numeracy on attitude and conceptual understanding of mole concept by Grade 11 students. *International Journal of Advanced Research and Publications, 3*(9), 16-23. https://www.ijarp.org/published-research-papers/sep2019/The-Effect-Of-Numeracy-On-Attitude-And-Conceptual-Understanding-Of-Mole-Concept-By-Grade-11-Students.pdf

Mulford, D. R., & Robinson, W. R. (2002). An inventory for alternate conceptions among first-semester general chemistry students. *Journal of Chemical Education*, *79*(6), 739-744. https://pubs.acs.org/doi/abs/10.1021/ed079p739

Mweshi, E., Munyati, O., & Nachiyunde, K. (2019). Teachers' mole concept pedagogical content knowledge: Developing the model for the mole concept content representations framework. *Journal of Education and Practice, 10*(8), 51-65. https://doi.org/10.7176/JEP/10-8-08

Okebukola, P. (2005). *Quality assurance in teacher education: The role of faculties of education in Nigerian universities*. A report presented to the committee of deans of Education of Nigerian Universities.

Ozmen, H. (2007). The effectiveness of conceptual change texts in remediating high school students' alternative conceptions concerning chemical equilibrium. *Asia Pacific Education Review, 8*(3), 413-425.

Petrucci, R. H., Herring, F. G., Madura, J. D., & Bissonnette, C. (2017). *General chemistry: Principle & modern applications* (11th ed.). Person Canada.

Priede, D., & Krumina, A. (2012). A Conceptual approach to learning chemistry in professional secondary school in Latvia. *US-China Education Review B 1,* 31-40. https://files.eric.ed.gov/fulltext/ED531658.pdf

Rollnick, M., Bennett, J., Rhemtula, M., Dharsey, N., & Ndlovu, T. (2008). The place of subject matter knowledge in pedagogical content knowledge: A case study of South African teachers teaching the amount of substance and chemical equilibrium. *International Journal of Science Education*, *30*(10), 1365-1387. https://doi.org/10.1080/09500690802187025

Santi, M. T., & Atun, S. (2020). Learning activities based on learning cycle 7E model: Chemistry teachers' perspective. *Advances in Social Science, Education and Humanities Research, 541,* 234-240. file:///C:/Users/HP/Downloads/125954758.pdf

Sarkodie, P. A., & Adu-Gyamfi, K. (2015). Improving students' performance in naming and writing structural formulae of hydrocarbons using ball and stick models. *Bulgarian Journal of Science Education, 24*(2), 203-219.

Shebu, G. (2015). The effect of problem-solving instructional strategies on students' learning outcomes in senior secondary school chemistry. *IOSR Journal of Research & Method in Education, 5*(1), 10-14. https://doi.org/10.9790/7388-05111014

Sirhan, G. (2007). Learning difficulties in chemistry: An overview. *Journal of Turkish Science Education*, *4*(2), 2-20.

Suchting, W. (1998). Constructivism deconstructed. In M. Mathews (Ed.), *Constructivism in science education* (pp. 61-92). Springer. https://doi.org/10.1007/978-94-011-5032-3_4

Taha, H., Hashim, R., Ismail, Z., Jusoff, K., & Yin, K. Y. (2014). *The influence of students' concept of mole, problem presentation ability and mathematical ability on stoichiometry problem solving.* A paper presented at the 2014 WEI International Academic Conference Proceedings, Bali, Indonesia.

Treagust, D., Nieswandt, M., & Duit, R. (2000). Sources of students' difficulties in learning chemistry. *Chemical Education*, *11*(2), 228-235. http://dx.doi.org/10.22201/fq.18708404e.2000.2.66458

Tsoi, R. M. F., Goh, N. K., & Chia, L. S. (1998). Some suggestions for the teaching of the mole concept. In M. Waas (Ed.), *Enhancing learning: Challenge of integrating thinking and information technology into the curriculum*: *Proceedings of the 12th Annual Conference of the Educational Research Association* (pp. 778-785). Educational Research Association. http://hdl.handle.net/10497/14982

Vorsah, R. E., & Adu-Gyamfi, K. (2021). High school chemistry teachers' perspectives and practices on teaching mole concept. *European Journal of Education Studies, 8*(2), 132-151. https://doi.org/10.46827/ejes.v8i2.3556

Voska, K. W., & Heikkinen, H. W. (2000). Identification and analysis of student conceptions used to solve chemical equilibrium problems. *Journal of Research in Science Teaching: The Official Journal of the National Association for Research in Science Teaching*, *37*(2), 160-176. https://doi.org/10.1002/(SICI)1098-2736(200002)37:2%3C160::AID-TEA5%3E3.0.CO;2-M

Wertsch, J. V. (2000). Vygotsky's two minds on the nature of meaning. In C. D. Lee & P. Smagorinsky (Eds.), *Vygotskian perspectives on literacy research: Constructing meaning through collaborative inquiry* (pp. 19-30). Cambridge University Press.

West Africa Examinations Council. [WAEC]. (2015). *Chief examiner's report: general science programme: May/June West Africa senior secondary certificate examination*. Author.

West Africa Examinations Council. [WAEC]. (2016). *Chief examiner's report: general science programme: May/June West Africa senior secondary certificate examination*. Author.

West Africa Examinations Council. [WAEC]. (2017). *Chief examiner's report: General science programme: May/June West Africa senior secondary certificate examination*. Author.

Zephrinus, C., & Phoebe, M. I. (2015). Resolving Nigerian secondary school students' learning difficulties in nuclear chemistry using computer animation solutions. *Procedia-Social and Behavioral Sciences*, *176*, 1034-1040.

APPENDIX A

THE QUESTIONNAIRE ON STUDENT KNOWLEDGE AND PERCEPTIONS OF MOLE

Dear student,
The purpose of this questionnaire is to explore perceptions students have about mole concept. It is for academic purpose only. Your assistance in providing the information is kindly requested by completing the attached questionnaire. There is no wrong or right response.
Please be assured that the information that you provided in the survey will be treated confidential.

SECTION A: BACKGROUND INFORMATION;

Tick only one

1. Sex of respondent
   [ ] Male
   [ ] Female
2. Age
   [ ] 10- 15years
   [ ] 16-19years
   [ ] 20 years and above

SECTION B: STUDENTS' PERCEPTIONS OF MOLE CONCEPT

Use the scale below to indicate the extent to which you agree or disagree with the following statements. (Please, provide responses where appropriate).

KEY

SA= Strongly Agree, A= Agree, UN= Uncertain, D= Disagree, SD = Strongly Disagree

Statement	SD	D	UN	A	SA
3. Mole concept is easy and interesting					
4. Mole concept is boring when taught using inadequate teaching approaches					
5. The chemical names and terms in mole concept are too complex for me to understand					
6. The concept of mole entails a lot such that in one way, it is compared with Avogadro's number of particles, while in the second way it is necessary to compare to mass of substance contained in the mole to 12 g of isotope carbon-12.					
7. I prefer rote learning of the mole concept because it is too difficult to understand					
8. Mole concept is too theoretical					
9. I spent more time in learning mole concept than other concepts in chemistry					
10. Mole concept is quite technical.					
11. The mole concept requires enough mathematical background knowledge.					
12. I did not master the skills of solving certain mathematical problems before learning mole concept and so, I do memorization to solve questions in mole concept.					
13. I had no previous knowledge relating to mole concept and so I find mole concept so strange to understand					
14. My teacher did not teach balancing of chemical equations and reactions before the mole concept, making it difficult to learn mole concept.					
15. My knowledge in atomic structure was minimal before I was taught the mole concept					
16. I, most of the time, consider mole as a mass, and I did not use it as a unit of the amount of substance.					
17. The mole concept is a concept which had to do with only molecules and not atoms.					
18. The mole concept is the only concept I always fail to understand, no matter how hard I try.					
19. I do not show much interest in learning mole concept because I don't like it					
20. The mole concept can be understood better if teachers teach with teaching learning materials.					

SECTION C: RECOMMENDATIONS ON HOW TO TEACH THE MOLE CONCEPT TO STUDENTS

21. In your views, how should the mole concept be taught by teachers to Senior High School students?

……………………………………………………………………………………………..……………
…………………………………………………………………….......................…………………………
………………………………………………………………………..………………

APPENDIX B

IN-DEPTH INTERVIEW GUIDE ON STUDENTS' KNOWLEDGE OF THE NATURE OF MOLE

Introduction

The researcher is with the Department of science Education, University of Cape Coast pursuing MPhil. Science Education and researching into "challenges facing the teaching and learning of mole concept" as part of her academic work. Your co-operation and support are highly needed if this research project is to be successful. You are kindly requested to make some time out of your busy schedules to participate in the study and as accurately and honestly respond to the issue to your best of ability. You are greatly assured that your anonymity and confidentiality are guaranteed. Information provided will be treated with the strictest confidence and the result of this research work will not be used in any way detrimental to your interest. Thank you very much for agreeing to be a part of this research work.

Interview Questions

Before the lesson on mole concept

1. Have you been introduced to mole concept?
2. What are some of the difficulties you encounter when learning mole concept?
3. Which aspects of mole concept do you face these difficulties in?
4. What account for these difficulties?
5. How do you overcome these difficulties?
6. What are your expectations in going into this lesson on mole concept?

After the lesson on mole concept

7. Did you meet your expectations?
8. Any reason for meeting or not meeting your expectations?
9. Are there some difficulties in this lesson?
10. If another teacher is going to teach you this topic next time, what should be the best way of teaching it?

Received: *November 20, 2021* Accepted: *January 20, 2022*

Cite as: Adu-Gyamfi, K., & Elikem Vorsah, R. (2022). Gender variations favouring male students in perceived nature of learning mole concept. *Problems of Education in the 21st Century*, *80*(1), 9-29. https://doi.org/10.33225/pec/22.80.09

Kenneth Adu-Gyamfi *(Corresponding author)*	PhD, Lecturer, Department of Science Education, University of Cape Coast, Ghana. E-mail: kenneth.adu-gyamfi@ucc.edu.gh ORCID: https://orcid.org/0000-0002-1959-3702
Rejoice Elikem Vorsah	MSc (Science Education) , Department of Science Education, Faculty of Science and Technology Education, University of Cape Coast, Ghana. E-mail: vorsahrejoice024@gmail.com

This is an open access article under the
**Creative Commons Attribution 4.0
International License**

PROBLEMS
OF EDUCATION
IN THE 21st CENTURY
Vol. 80, No. 1, 2022

AN ENTREPRENEURIAL SCIENCE THINKING MODULE BASED ON THE SOCIOSCIENTIFIC ISSUES APPROACH WITH THINKING WHEEL MAP FOR PRIMARY SCHOOL STUDENTS IN STEM EDUCATION

Jamilah Ahmad, Nyet Moi Siew
University Malaysia Sabah, Malaysia

Abstract

The design and development of modules in cultivating entrepreneurial science thinking (EST) in STEM education at the primary school level is still limited. Thus, this research was conducted to i) establish the validity, reliability and feasibility of the module based on the socioscientific issues approach aided by the thinking wheel map (SIA-TM), and ii) evaluate its effects on the EST among fifth graders in STEM education. Data were collected via respondents' feedback in the 5-point Likert scale questionnaire and an EST test. The first phase of the module evaluation was conducted by five expert evaluators and among 30 fifth graders. The second phase was evaluation through the quasi-experimental research design with the pre-test post-test control group design. A total of 60 fifth graders were gathered into two groups which were the SIA-TM group (n=30) and control group (n=30). The results of the SIA-TM module evaluation shows that the validity value was good, and the alpha Cronbach reliability was between .74 and .89 with the overall value of .92. The students showed a high level of acceptance (m=4.53) towards the activities in the SIA-TM Module. Feedback from the students showed the module's feasibility and acceptance by students. The results of the t-test prove a significantly positive effect on the five constructs in EST. Therefore, these results establish that the SIA-TM teaching and learning module is valid, reliable, feasible and effective in increasing fifth graders' EST in STEM education.

Keywords: *entrepreneurial science thinking, socioscientific issues approach, STEM education, thinking wheel map*

Introduction

Entrepreneurial thinking has gained attention in science curriculum due to the need for developing individuals who can think critically, creatively, innovatively, and inhibit high values. Entrepreneurial thinking is recognised as one of the most relevant skills that should be mastered by students to face an increasingly challenging future (Bacigalupo et al., 2016; Buang et al., 2009). This skill is not merely for the purpose of becoming an entrepreneur but is an intrinsic skill that is important for establishing human development, fulfilling the market's demands, and increasing competition (Bacigalupo et al., 2016).

Entrepreneurial science thinking, on the other hand, is not a philosophy that aims to develop only entrepreneurs, but it is a design-thinking skill based on scientific knowledge and entrepreneurial orientation (Buang et al., 2009). According to Buang et al. (2009), designing a model requires students to master five important constructs of entrepreneurial science thinking which are observation, new ideas, innovation, creativity, and values. The mastery of these constructs aids students to generate ideas, choose ideas, sketch designs, create models and evaluate the contribution of their design to society.

Kicking off with this awareness, there arises a high need to apply entrepreneurial thinking in the curriculum (Saavedra & Opfer, 2012). Like other countries, Malaysia is now preparing school students to be globally competitive in the 21st century. In its Primary School Standard Curriculum 2017 edition, the element of entrepreneurial curriculum has been applied in all subjects including Science. Ironically, the module that is supposedly used to inculcate entrepreneurial science thinking in STEM education at the primary school level is very limited and restricted. Whereas Karlsson et al. (2021) stated that emphasis on innovation and entrepreneurship is incredibly significant to face the 21st century. Thus, there is a need for compatible research that synchronises with the needs of the Malaysian Education Development Plan (2013-2025) that encourages the application of Elements Across the Curriculum in the TL process of entrepreneurship (Ministry of Education Malaysia, 2012).

Therefore, a teaching and learning (TL) module which integrates STEM, innovation and entrepreneurship needs to be introduced in the school curriculum for students to become designers, innovators, and possess entrepreneurial values. In fact, emphasis on the entrepreneurial element in STEM education is another effort to attract students' interest to study STEM subjects besides studying the ways of commercialising ideas with the integration of various fields of study. Since there exist gaps and issues in implementing the application of entrepreneurial science thinking in the curriculum, a TL module that is based on socioscientific issues approach aided by a thinking wheel map (SIA-TM) was developed and its effects on entrepreneurial science thinking in STEM education was determined.

Theoretical Framework

The design and development of SIA-TM teaching and learning module based on the analysis of various elements was proposed such as the application of socioscientific issues approach, the use of thinking wheel map, the implementation of STEM education in primary schools, understanding towards the learning styles of primary school students and its relation to theories and teaching models. The SIA-TM teaching and learning module applied the concept of knowledge construction by adapting to the environment following Piaget's theory of cognitive constructivism (1976) and Vygotsky's theory of social constructivism (Vygotsky, 1978). Piaget's theory is compatible with fifth graders in this research as it focuses on the concept of using their prior knowledge to analyse socioscientific issues and design products that can solve issues presented to them. Through the discussions and solutions of socioscientific issues, students would undergo a process of exploration and recognise their own prior knowledge. The impact of this is a balance between the assimilation and accommodation processes towards new information based on their existing knowledge (Sjøberg, 2007).

In line with the students' ages (10-11 years old), Piaget's theory of cognitive constructivism states that these children are within the concrete operational stage where they are able to investigate and solve concrete problems rationally (Pascual-Leone & Johnson, 2005). Therefore, in this research students were presented with stimulating material such as socioscientific issues and pictorials that were suitable for their cognitive stage. Additionally, in line with Vygotsky's theory of social constructivism, students were assigned into small groups to enable teamwork activities and generation of ideas. Indirectly, discussion activities in these small groups applied the social aspect into the students' learning process (Jones & Brader-Araje, 2002).

Researchers realise the importance of pedagogical principles in the process of teaching and learning (TL) in primary schools to support the process of information and knowledge construction cognitively and socially. This research applied the socioscientific issues approach (Sadler et al., 2017) and thinking wheel map (Bengston, 2016; Bloom, 1956; Glenn, 1972) in the module development.

The socioscientific issues approach (SIA) was used because its suitability in terms of psychological, social, and emotional growth for children as well as its usability in various aspects in science education (Zeidler & Nichols, 2009). Teachers that use SIA in learning sessions help students to develop and evaluate arguments related to current issues (Owens et al., 2017). The first phase is focused on the issue at hand. In this phase, students build their understanding by relating issues with scientific ideas and community awareness. The second phase prepares a platform for teachers to encourage their students to understand and practice science that stresses on socioscientific and community issues. In this way, students are actively involved to search for relations between social issues and scientific knowledge and practices that boosts the relevance of the issues to be solved (Sadler et al., 2017). The last phase encourages students to synthesise ideas and practices. This phase provides students opportunities to be actively involved in manifesting ideas and opinions ethically.

Through the research of Birmingham and Barton (2014) and Nam and Chen (2017), the SIA has become the chosen approach to solve scientific, technological and community issues. SIA is observed to help increase students' scientific knowledge (Driver et al., 2000; Kinslow & Sadler, 2018; Sadler et al., 2017; Topçu et al., 2018). Scientific knowledge that is generated through socioscientific debates will drive students to produce ideas effectively because they have to relate the contributions of their inventions to real issues in society.

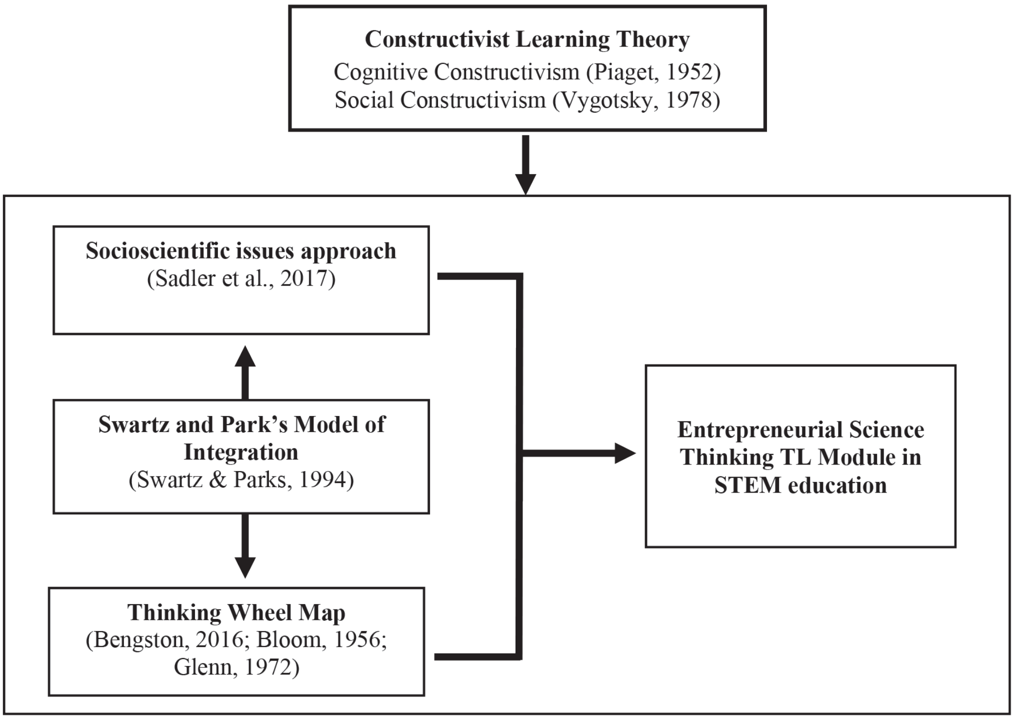
The thinking wheel map was adapted from Bloom (1956), Glenn (1972) and Bengston (2016). The thinking wheel map consists of a circle in the centre and five stages which could help students to produce and organise their ideas. When using the SIA-TM module, the students were given socioscientific issues for discussion and debate. Any logical and scientific ideas will be written onto the centre of the map. These scientific ideas will trigger students to contribute ideas in the next stage. Bengston (2016) stated that thinking wheel map is easily understood by students and stimulates their systematic thinking. This statement is compatible with this study's application where students needed to generate ideas in groups through brainstorming sessions. Any logical and feasible idea will be entered into each stage. Moreover, the thinking wheel map aids students to collect ideas speedily.

To integrate the socioscientific issues approach with the thinking wheel map, the researchers used the method of thorough integration (Swartz & Parks, 1994). With this method, the entrepreneurial science thinking skill is taught together with the contents of the lesson. The thorough integration was taught in five steps, that are: (i) introduction, (ii) thinking actively, (iii) thinking about thinking, (iv) reinforcement exercise, and (v) thinking application. In this case, two components (learning content and entrepreneurial science thinking skill) are implemented as complementary in each step of the process.

In developing the unit activity in the module, the researchers applied the entrepreneurial science thinking model proposed by Buang et al. (2009), which was divided into five steps that are i) plan and do purposeful observation [Observation], ii) create ideas by looking for uniqueness or strengths [New Ideas], iii) choose ideas that can be modified or improved and evaluate those ideas [Innovation], iv) strengthen and improve good ideas in a focused manner [Creativity], and v) ensure that ideas or products are meaningful for society [Value].

The ADDIE Model (Branch, 2010) which consists of five phases that are analysis, design, development, implementation, and evaluation was adopted in the design and development of SIA-TM teaching and learning module. The ADDIE Model was selected because it focuses on student-centred learning, its learning design is goal oriented, and it enables students to show meaningful actions and solve issues practically. The theoretical framework for the design and development of the SIA-TM teaching and learning module is shown in Figure 1.

Figure 1
Theoretical Framework for the Design and Development of SIA-TM Teaching and Learning Module


Constructivist Learning Theory
Cognitive Constructivism (Piaget, 1952)
Social Constructivism (Vygotsky, 1978)
Socioscientific issues approach
(Sadler et al., 2017)
Swartz and Park's Model of Integration
(Swartz & Parks, 1994)
Thinking Wheel Map
(Bengston, 2016; Bloom, 1956; Glenn, 1972)
Entrepreneurial Science Thinking TL Module in STEM education

Purpose and Research Questions

This research was conducted to design and develop a teaching and learning module that integrated the socioscientific issue approach and thinking wheel map to inculcate the entrepreneurial science thinking in STEM education among fifth graders. There were three research questions that drive this study:

1. Was the SIA-TM Module valid, reliable, and feasible for fifth graders?
2. Was there a significant difference between pre-test mean scores and post-test mean scores in entrepreneurial science thinking among fifth graders who were taught i) using the SIA-TM module, and ii) those in the control group?
3. Was there a significant difference between fifth graders who were taught using the SIA-TM module and those in the control group in i) pre-test mean scores, and ii) post-test mean scores in entrepreneurial science thinking?
4. What were the fifth graders' experiences in using the SIA-TM Module in STEM education?

Research Methodology

Research Design

This research applied a descriptive and quasi-experimental research design. Descriptive design involves evaluation from the aspect of validity, reliability and feasibility of the SIA-TM teaching and learning module. Whereas the quasi-experimental research design was employed to determine the effects of SIA-TM module on fifth graders' entrepreneurial science thinking. The effects of module were determined by the fifth graders' performance in entrepreneurial science thinking test as stated in research question number Two and Three. This research was conducted over 12 weeks beginning from October to December 2020.

Research Sample

The descriptive research involved 30 fifth graders and five experts. According to Chua (2011), a total of 30 respondents are needed to measure the internal consistency or reliability of a new instrument, which is evaluated by Cronbach's alpha. Yurdugül (2008) recommended 30 as the sufficient sample size when calculating the Cronbach's alpha. This number is corroborated by Bujang et al. (2018) and Conroy (2021) who stated that a pilot testing required a minimum of 30 respondents as the sample to determine the Cronbach's alpha. A total of 60 fifth graders were involved in the quasi-experiment who were from two randomly chosen schools in Tawau, Sabah. These students were grouped in two groups that is, the SIA-TM group (n=30) and control group (n=30). They stood of 29 (48%) males and 31 (52%) females. 60% of these students' parents work in the government sector while 40% work in the private sector or are involved in the business sector.

Ethical Considerations

At the early stage of this research, the researchers obtained consent from the headmasters, teachers, and students. The students were provided letters of agreement for their parents' approval for their involvement in the research. The agreement letter detailed the students' involvement in the research and the parents' agreement showed their understanding about the study's purposes. All the respondents were informed about the confidential nature of the research and that they could pull out from the research without facing any punishment.

Descriptive Research

Analysis Phase

The main purpose for the design of SIA-TM module was to encourage and inculcate entrepreneurial science thinking among fifth graders in STEM education that is taught in the science subject. To achieve the objectives of this research, researchers conducted an analysis towards the needs of the students and context of the study. At the needs analysis stage, the researchers interviewed five primary school science teachers in Tawau, Sabah. The interviews were conducted from 5 – 7 September 2020 at the primary teacher's room to gain a picture on inculcating entrepreneurial science thinking through the teaching and learning process. All the teachers responded that they received little exposure to the concept of entrepreneurial science and its teaching process because they had no guide or teaching and learning module that they could refer to in relation to applying entrepreneurial science thinking in primary school. Via these interviews, the researchers also realised that these teachers had never undergone any course or training related to entrepreneurial science thinking.

In the analysis of students and context, the criteria were adapted from Carlton et al. (2000) that focused on students' low achievement level, student's prior knowledge about Physical Science and Technology and Sustainable Life themes, sketching skills, creation skills and peer pressure. 30 respondents were chosen for their feedback on this analysis. The analysis showed that students were unanimous in their opinions on all the aspects except for the aspect of prior knowledge about Physical Science and Technology and Sustainable Life themes which they considered they were weak in. Therefore, the teaching process in SIA-TM module was adapted to the fifth-graders' level and needs as best as possible.

Design and Development of SIA-TM Module

The SIA-TM Module was developed by adapting the socioscientific issues approach that introduces social issues to students which helps them to study the social and scientific components of those issues, as well as encourage them to generate solutions that are based on societal values. To help the students solve socioscientific issues given to them, the thinking wheel map was provided as a thinking tool. The socioscientific issues approach and thinking wheel map were integrated through the Swartz and Parks' (1994) integrated thinking model.

The module has six STEM teaching and learning activities that covers Physical Science and Technology and Sustainable Life themes as found in the latest edition of the Fifth Grade Science Curriculum and Assessment Standard Documents (Curriculum Development Division, 2019). Every activity was allocated 180 minutes. However, this time suggestion for the activity implementation can be customised according to the TL in school as this module can be executed outside TL hours.

Furthermore, the SIA-TM module was also designed to increase students' entrepreneurial science thinking towards STEM via five stages, that are (i) observation (planned and purposeful observation), (ii) new ideas (create ideas by finding uniqueness or strengths), (iii) innovation (select several ideas that can be modified or improved and evaluate those ideas), (iv) creativity (strengthen and improve ideas with focus) and (v) value (ensure that the idea or product created is meaningful to society).

In the observation stage, students were instructed to make planned and purposeful observation. Students were provided with stimulus pictures that showcased the product designs nowadays. Then, students were asked to make observations to garner information on the building materials, design, and product characteristics.

Next, students were tasked at thinking ideas to look for uniqueness and strengths. This stage encouraged students to search for the uniqueness and strengths of the building materials, design, and product characteristics in the product they had observed.

The innovative stage refers to the students' activity of selecting several ideas that can be modified or improved and observe those ideas. The selection of ideas that can be improved helped the students to create a product design in the future. Students then had to evaluate those ideas by stating their reasons for choosing them.

As for the creative stage, this activity is to strengthen and increase ideas in a focused manner based on the ideas that were chosen previously. Students upgraded their ideas by making sketches, labelling, and building the product design model. Next, students had to determine the name of the product, its offer price and target group of buyers.

Lastly, the value stage was for the students to ensure that their ideas or product was useful to society. Students stated the benefits of the product to society. They could state the product's strengths in terms of its cost saving qualities, product functions and properties as well as ethics involved in the creation of the product. This was to inculcate values such as love for the environment and the practice of using sustainable materials in creating a product for society. The students then had to present their creations in class and explain the benefits of their products.

All these stages were carried out in stage according to the thinking wheel map stage. These five stages involved different student activities. To gain maximum effect, the activities in this module were executed in groups to ensure the exchange of ideas and search of creative and innovative solutions. In this module's implementation, the teachers' instructions and guidance was needed. Table 1 shows the integration of the socioscientific issues approach and thinking wheel map in increasing the effects of entrepreneurial science thinking learning module.

Table 1
Integration of SIA Approach and TM in the Entrepreneurial Science Thinking TL Module

Socioscientific Issues Approach (SIA)	Thinking Wheel Map (TM)	Integration of SIA and TM in the Entrepreneurial Science Thinking TL Module
Phase 1 Students discover or are introduced with an issue	**First Stage - Observation** Planned a purposeful observation	**Introduction** Teacher introduces a socioscientific issue to students and instructs students to make an observation towards an issue in the first stage of TM.
Phase 2 Students study the social and scientific components related to issues in the first phase.	**Second Stage – New Ideas** Create ideas by looking for uniqueness or strengths in a product that is observable in building materials, design, and products' characteristics.	**Think actively** Socioscientific issues and stimulus materials are used as a guide for students to generate ideas by finding uniqueness or advantages through the second stage of TM
	Third Stage – Innovation Selection of several ideas that can be modified or improved and evaluate those ideas	**Thinking about Thinking** Students are stimulated to choose several ideas that can be modified or improved and evaluate those ideas through the third stage of TM to solve the issues that are presented.
Phase 3 Students try to generate a solution based on societal values.	**Fourth Stage – Creativity** Strengthen and improve the selected ideas in a focused manner	**Consolidation Practice** Students strengthen and improve the ideas they have chosen in a focused manner in the fourth stage of TM and sketch their ideas for the product.
	Fifth Stage – Value Ensure that the idea or product that is created is meaningful for society.	**Applying Thinking** Students state and ensure that the characteristics of their products is useful to society and can solve the issues presented in the fifth stage of TM.

In designing and developing SIA-TM Module, the STEM element is integrated in the stages of the activity. Appendix shows how the STEM elements are integrated in one of the activities in SIA-TM Module named *The New Century Car* based on the tasks requested in each stage.

Evaluation Phase

Taherdoost (2016) stated that a module's content must be verified before it can be applied. The second phase of evaluation is conducted to evaluate the module's reliability, feasibility, and respondents' acceptance. This phase can be conducted after the SIA-TM Module has been shared with the respondent through the process of TL. As suggested by Cohen and Swedlik (2018), a good module usually has a high level of validity and reliability.

A panel of five experts were involved to check the validity of the module's content. These experts were university lecturers, teachers' institute lecturers and primary school science teachers. The entrepreneurial science thinking and STEM experts were a professor from a public university and a lecturer from a teaching institute. The other two experts were teachers with a vast experience in primary school science education.

To measure the module's content validity, an evaluation form was provided to the experts to enable them to provide feedback about the pedagogical content (socioscientific issues approach, thinking wheel map and STEM), overall picture of the activity, suitability of each lesson plan, learning standard, overall process of the activity units, integration of the five entrepreneurial science thinking steps, and provide written comments to improve the module. The SIA-TM module was created in Bahasa Melayu to ensure primary school teachers' understanding of the module's content.

A questionnaire was also distributed to the respondents to gather their perceptions about the feasibility of activities proposed in the SIA-TM module. The questionnaire used the 5-point Likert scale with the value 1 (strongly disagree) till 5 (strongly agree). As many as 11 questions were adapted from Rahman (2020) which required students to provide their feedback from the aspect of feelings, benefits from the execution of the five-step entrepreneurial science thinking, the use of the socioscientific issues approach and thinking wheel map.

To establish the reliability of the SIA-TM module, another questionnaire was adapted from Ambo (2019) and given to the respondents. Noah and Ahmad (2005) posit that questionnaires based on activities show a higher reliability index compared to objectives in a module. There were six activities in the SIA-TM module and each activity in the module was evaluated using the Likert Scale starting with the value of 1 (strongly disagree) till 5 (strongly agree). The items that were questioned in each activity were conducted to help respondents cultivate the five constructs of entrepreneurial science thinking that were suitable with the module's learning outcomes. All 30 items were presented in a suitable language level for the primary school level. Both questionnaires were given to 30 fifth graders in the SIA-TM group as soon as the intervention using the module was conducted.

The closing phase (evaluation phase) was done via focus group interviews to gain students' feedback about the SIA-TM module's implementation. They were asked to share their feelings and experiences after using the SIA-TM module and elaborate how the module's use could impact them from the aspect of their entrepreneurial science thinking.

Quasi Experimental Research

The implementation phase of the experimental research involved the implementation of the teaching and learning (TL) of the SIA-TM module as well as to evaluate its effects in the classroom's session of teaching and learning. In line with this, the pre-test – post-test control group design was employed. A total of 60 students were chosen randomly from two primary schools in the Tawau district and were placed into two groups: treatment group (SIA-TM, *n*=30), and control group (GC, *n*=30). The respondents in the treatment group received the SIA-TM module that comprised of six learning units for 12 weeks from October to December 2020. Each unit required the implementation time of 180 minutes with three missions to be solved; Mission 1: Discussion of socioscientific issues, Mission 2: Discussion of model design, and Mission 3: Presentation of the model design. These three missions could be conducted in three stages according to the suitability of the school's teaching and learning timetable. The respondents in the control group were exposed to the method of designing a conventional design without the use of the socioscientific issues approach and thinking wheel map.

To evaluate the module's effects, the Entrepreneurial Science Thinking Test (ESTT) (Ahmad & Siew, 2021) that was designed by the researchers was used. This instrument was proven to be valid, reliable and suitable to evaluate fifth-graders' entrepreneurial science thinking. The ESTT consisted of 10 items that required students to answer questions in the form of statements and idea sketches. The questions were constructed based on the five constructs in entrepreneurial science thinking (Buang et al., 2009) which were referred to from the Curriculum and Assessment Standard Document (CASD) Grade Five Science learning contents under the Physical Science and Technology and Sustainable Life themes (Curriculum Development Division, 2014,p. 61-79). The main question asked students to create a handphone design to be used by future society. The context of using handphones was chosen because it is contained in the CASD under the Physical Science theme. Students were then provided a stimulus picture and 10 questions that were arranged according to the cluster construct to enable students to organise their answers and get the desired results. The ESTT scoring was done based on the scoring of Ho et al. (2013). Each item that was prepared in this test carried a minimum score of zero and maximum score of three.

Data Analysis

The descriptive research data were gained through calculating the percentage, mean and standard deviation while the inferential research data were tabulated through the IBM SPSS (version 26) analysis. For this analysis, the level of significance was set to the value of .05. The analysis of qualitative interview data was done using thematic analysis (Braun & Clarke, 2006) by deriving themes from the interviews about the experiences gained by the 30 fifth graders after using the SIA-TM module. The researchers analysed the interview data thoroughly and gained the pattern linkage from the respondents' experiences and explained the respondents' experiences (Fereday & Muir-Cochrane, 2006).

Research Results

Content Validity

Following the experts' advice, several amendments were made towards the content and activities in the SIA-TM module; i) the design activity according to five constructs was refined to fulfil the entrepreneurial science thinking concept; ii) the lesson plan format of writing was simplified for better clarity; iii) the writing based on learning outcome was specified following the content standard of each unit; iv) the arrangement of activities in the module was changed according to the standard arrangement of contents in the CASD; and v) a simple explanation was inserted for each important concept to increase the readers' understanding. Overall, the expert evaluators agreed that the SIA-TM module was a suitable module to inculcate entrepreneurial science thinking amongst fifth graders.

.

Reliability

The reliability of module was determined based on the internal consistency coefficient of Cronbach Alpha. (Cohen et al., 2018). The reliability of the module was assessed after the respondents could master the objectives and could follow the steps in each activity in SIA-TM module at a good level of understanding. Hair et al. (2006) suggested that a Cronbach alpha ≥ .7 was acceptable while Sekaran and Bougie (2010) stated that a Cronbach alpha ≥ .8 usually meant a high reliability. Table 3 shows the Cronbach Alpha values for the learning activities in the SIA-TM module that was gained from the 10-item questionnaire on the 30 respondents. The overall Cronbach Alpha value of SIA-TM module was .82 with a value between .74 to .89 for each unit. This showed that a high reliability level for each activity unit in the module and overall SIA-TM module.

Table 3
Cronbach Alpha Value for Activity Units in the SIA-TM Module

Unit	Units in the module	Cronbach Alpha Value
1	New Century Car	.89
2	Energy Saving Light	.77
3	My Solar Spectacles	.79
4	Five Stars Television	.84
5	My Sustainable Home	.86
6	Eco-Friendly Food Container	.74
	Total	.82

Students' Perceptions about the Feasibility of SIA-TM Module

Table 4 showcases the students' perceptions about the feasibility of SIA-TM module, and it was collected via the questionnaire given to the respondents. The overall mean of 4.53 showed that the SIA-TM module had high value of acceptance and feasibility. 30% of the respondents agreed while 63% strongly agreed with the SIA-TM module's feasibility. The criteria that show a minimum mean of 3.50 shows that the feasibility aspect of the module is acceptable (Junus et al., 2021). However, if the mean level was below 3.50, changes will have to be made because the module's feasibility will be considered unsatisfactory. The research findings between the levels of 4.06 to 4.86 proved that the SIA-TM module was feasible in cultivating entrepreneurial science thinking among fifth graders.

Table 4

Percentage and Mean for Students' Perceptions about the Feasibility of SIA-TM Module

	Pedagogical feasibility criteria	**Percentage and mean according to Likert Scale**					
		1 Strongly Disagree	2 Disagree	3 Neutral	4 Agree	5 Strongly Agree	Mean
1	The science learning activities which use the SIA-TM module stimulates my thinking to look for solutions for the social issues brought up.	0 (0)	0 (0)	1 (3)	5 (17)	24 (80)	4.76
2	The science learning activities which use the SIA-TM module encourages me to create many new ideas.	0 (0)	0 (0)	0 (0)	14 (47)	16 (53)	4.53
3	The science learning activities which use the SIA-TM module stimulates my mind to create ideas that can be applied to current needs.	0 (0)	1 (3)	2 (7)	10 (33)	17 (57)	4.43
4	The science learning activities which use the SIA-TM module stimulates my mind to expand my initial ideas to more interesting new ideas.	0 (0)	1 (3)	2 (7)	7 (23)	20 (67)	4.53
5	The science learning activities which use the SIA-TM module stimulates my mind to create designs that can benefit society.	0 (0)	0 (0)	1 (3)	14 (47)	15 (50)	4.47
6	The science learning activities which use the SIA-TM module increases the quality of the module design.	0 (0)	2 (7)	4 (13)	14 (47)	10 (33)	4.06
7	The science learning activities which use the SIA-TM module increases my science knowledge.	0 (0)	0 (0)	0 (0)	4 (13)	26 (87)	4.86
8	The science learning activities which use the SIA-TM module increases entrepreneurship orientation in me.	0 (0)	2 (7)	2 (7)	13 (43)	13 (43)	4.23
9	I enjoyed learning Science using the SIA-TM module.	0 (0)	1 (3)	2 (7)	8 (27)	19 (63)	4.50
10	My curiosity in STEM education has increased after learning Science using the SIA-TM module.	0 (0)	1 (3)	2 (7)	6 (20)	21 (70)	4.57
11	I am interested now to follow learning activities using the SIA-TM module in the future.	0 (0)	0 (0)	0 (0)	5 (17)	25 (83)	4.83
	Total	0 (0)	8 (2)	16 (5)	100 (30)	206 (63)	4.53

Effects of the SIA-TM Module

Paired Sample t-Test

The paired sample *t*-test was executed to determine whether there was any significant difference between the pre-test and the post-test mean scores for the SIA-TM group from the aspect of the five constructs of entrepreneurial science thinking. Research results in Table 5 show that the post-test mean score was significantly different from the pre-test mean score from the aspect of these constructs: Observation, New Ideas, Innovation, Creativity and Value. Each value was ($t(29) = -20.707$, $p < .05$; $t(29) = -23.404$, $p < .05$; $t(29) = -28.580$, $p < .05$; $t(29) = -25.284$, $p < .05$; $t(29) = -24.814$, $p < .05$). These findings show that the SIA-TM group performed better in the post-test compared to the pre-test in the five constructs of entrepreneurial science thinking.

The findings of paired sample t-test sample for the control group (CG) (Table 5) also showed a higher significant difference for the post-test compared to the pre-test from the aspect of the Observation, New Ideas, Innovation, Creativity and Value constructs with each value at ($t(29) = -7.990$, $p < .05$; $t(29) = -7.999$, $p < .05$;$t(29) = -5.530$, $p < .05$; $t(29) = -6.998$, $p < .05$; $t(29) = -7.940$, $p < .05$). These findings also prove that the control group performed better in the post-test compared to the pre-test in the five constructs of entrepreneurial science thinking.

Table 5
Results of Paired Sample t-test Analysis

Construct	Group	Pre-Test	Post-Test	Difference	*t*	*df*	*p*
		Mean (Standard Deviation)					
Observation	SIA-TM	2.37 (.669)	4.93 (.640)	-2.567 (.679)	-20.707	29	< .05
	CG	2.30 (.596)	3.57 (.568)	-1.267 (.868)	-7.990	29	< .05
New Idea	SIA-TM	2.23 (.679)	4.97 (.615)	-2.733 (.640)	-23.404	29	< .05
	CG	2.27 (.691)	3.40 (.894)	-1.133 (.776)	-7.999	29	< .05
Innovation	SIA-TM	2.47 (.819)	5.07 (.868)	-2.600 (.498)	-28.580	29	< .05
	CG	2.50 (.731)	3.33 (.661)	-.833 (.699)	-6.530	29	< .05
Creativity	SIA-TM	2.57 (.774)	5.17 (.699)	-2.600 (.563)	-25.284	29	< .05
	CG	2.60 (.621)	3.63 (.765)	-1.033 (.809)	-6.998	29	< .05
Value	SIA-TM	2.40 .675)	5.10 (.712)	-2.700 (.596)	-24.814	29	< .05
	CG	2.40 (.675)	3.50 (.682)	-1.100 (.759)	-7.940	29	< .05

Note: Significance level at p=.05

Independent Sample T-Test

Independent sample *t*-test was conducted to compare the pre-test mean score for the five constructs between the SIA-TM and CG. Analysis results (Table 6) indicated that there were no significant differences between the pre-test mean scores between SIA-TM and CG in the Observation, New Ideas, Innovation, Creativity and Value constructs with each construct's value at ($t(58) = .408$, $p >.05$; $t(58) = -.188$, $p > .05$; $t(58) = -.166$, $p > .05$; $t(58) = -.184$, $p > .05$; $t(58) = 0.00$, $p > .05$).

Gay and Airasian (2003) stated that if there were no significant differences for the mean scores between the two pre-tests, then the *t*-test could be conducted on the post-test mean score.

Thus, the independent sample *t*-test was carried out to compare the SIA-TM and the CG mean scores in the five constructs of entrepreneurial science thinking. The analytical results show that the respondents in the SIA-TM group had a significant higher post-test mean score compared to the control group from the aspect of Observation, New Ideas, Innovation, Creativity and Value constructs with each value at ($t(58) = 8.748, p < .05$; $t(58) = 7.906, p < .05$; $t(8) = 8.700, p < .05$; $t(58) = 8.106, p < .05$; $t(58) = 8.887, p < .05$). These results proved that there was a significant difference in the post-test for students from the SIA-TM group compared to those in the CG in the five constructs of entrepreneurial science thinking.

Table 6

Results of the Independent Sample t-test Analysis

Construct	Test	SIA-TM Group Mean (SP)	Control Group Mean (SP)	Group Difference	*t*	*df*	*P*
Observation	Pre	2.37 (.669)	2.30 (.596)	.067 (.164)	.408	58	> .05
	Post	4.93 (.640)	3.57 (.568)	1.367(.156)	8.748	58	< .05
New Ideas	Pre	2.23 (.679)	2.27 (.691)	-.033 (.177)	-.188	58	> .05
	Post	4.97 (.615)	3.40 (.894)	1.567 (.198)	7.906	58	< .05
Innovation	Pre	2.47 (.819)	2.50 (.731)	-.033 (.200)	-.166	58	> .05
	Post	5.07 (.868)	3.33 (.661)	1.733 (.199)	8.700	58	< .05
Creativity	Pre	2.57 (.774)	2.60 (.621)	-0.33 (.181)	-.184	58	> .05
	Post	5.17 (.699)	3.63 (.765)	1.533 (.189)	8.106	58	< .05
Value	Pre	2.40 (.675)	2.40 (.675)	0.00 (.174)	0.00	58	> .05
	Post	5.10 (.712)	3.50 (.682)	1.600 (.180)	8.887	58	< .05

Note: Significance level at p=.05

Interviews with the Focus Group

Several themes were identified based on the respondents' views in the focus group interviews towards the implementation of the SIA-TM teaching and learning module. A total of three focus groups were involved with each consisting of five respondents. The abbreviation used for the analysis was 'G' represents Group. The findings are as follows:

Arrangement of ideas and expansion of new ideas. The use of the SIA-TM module helped students to arrange their ideas in a more organised way and expanded their new ideas.

> *"...when we were asked to write in the wheel… we were thinking why we have to use the wheel... can't we just create the product… but when we did it… the ideas came one by one… then (we realised) the importance of the wheel… If there was no wheel… it would be difficult...we wouldn't know how to arrange ideas... this map gave a new opportunity to us to open our ideas..." (G2)*
>
> *"...before we created an object… we were very nervous… but when we used the map… it really helped… we felt it was easy to create… the wheel map has stages... so this really helps… till the fourth stage, we felt this task was actually easy...ideas could be arranged easily... we could create a product more systematically..." (G3)*
>
> *"... any ideas that came to our minds and ideas that we thought would not be forgotten..." (G1)*

Increase in STEM knowledge. Students also stated that the SIA-TM module increased their STEM knowledge.

> *"…We were really excited to learn STEM with this method… socioscientific issues really helped us to produce eco -friendly products…" (G1)*

> *"…this module is really new for us… if we don't join this learning experience ... we don't even know that our environment is already bad polluted... it's like the polystyrene issue ... we really don't think why can be so much… that's why our team produce food containers that do not pollute the environment ... we use banana leaves that are easily biodegradable…" (G2)*

> *"...At first, we asked ourselves what STEM is. After writing in the wheel map, then we could understand… because we had to produce products that used the knowledge of science, technology, engineering and mathematics... when producing a car… we have to sketch the car… build it according to the appropriate material… calculate the speed of the car… set the price of the car and we use water as car fuel to produce hydrogen which is safer for nature…" (G3)*

Excitement when creating a prototype. Students expressed their excitement and thrill when creating their prototypes.

> *"... we created a car that used water because the use of fossil fuels is not good for the environment... we felt this was very fun because the map helped us to create the car… We arranged our ideas one by one until the car was created..." (G2)*

> *"…We're impressed with ourselves … our group did not expect to create a product for the future... we were really… really happy..." (G3)*

Inculcates the value of helping the society in the future. The use of the innovative SIA-TM module proved to help students to cultivate a feeling of responsibility to solve universal issues to help future society.

> *"...at first, we were given issues to discuss... we also did not know that our world is facing the issues that our teacher showed us... so on the wheel map, we wrote the issues that we discussed... then we wrote ideas to create a product... that helps the society in the future..." (G1)*

> *"... at first… we were scared that this project would not work out... but when it was done as a group... we could create a product that we wanted for the future community…" (G2)*

Increase of curiosity. The students' curiosity was also increased through this innovative SIA-TM module.

> *"... during the creation of our product… we asked each other questions in our group… because we want to know what would happen if we did something like this… we wanted to know the outcome..." (G3)*

> *"... actually… we were afraid that our plan would not work out... but after writing ideas on the wheel map… we did what was planned… we were impatient to know what would happen next..." (G1)*

Encourages teamwork in a group. The value of teamwork and unity in a group could be brought out through the innovative SIA-TM module.

> *"... the wheel map helps us to collaborate in creating our group project..." (G1)*

> *".. at first… we were scared that this project would not work. But after doing it as a group… we managed to produce our product for the future society… for example... when making the eco-friendly food containers… we discussed together how to produce food containers from more sustainable banana leaves…" (G2)*

> *"...we felt nervous because we were scared to get it wrong… but after doing it… we felt happy... all of us did it together… the wheel was done together… we discussed together to get ideas... finally… we succeeded..." (G3)*

Discussion

This research was carried out to develop a SIA-TM module that is more geared towards meeting the needs of students facing the global challenges of twenty first century. To ensure its applicability in primary schools, assessments on its validity, reliability, feasibility, and effect were analysed. The SIA-TM module was developed based on a clear and detailed theoretical framework which integrated the socioscientific issues approach and the thinking wheel map using the Swartz and Park's model of integration to measure the effect it had on the five constructs of the entrepreneurial science thinking.

Overall, the results have proven that the SIA-TM module had a valid and reliable content which is feasible in increasing fifth-graders' entrepreneurial science thinking. The analysis on the module's content validity proves that the SIA-TM module was well received by the panel of five expert evaluators. It also underwent several improvements towards a few aspects in the module. The reliability analysis showed that the SIA-TM module was within an acceptable range based on Cronbach's Alpha value.

The paired sample *t*-test showed that fifth graders in both the SIA-TM and CG groups displayed a significant better performance in the five constructs of entrepreneurial science thinking in the post-test compared to the pre-test. Nevertheless, the fifth graders that were taught in the SIA-TM group had a higher improvement score compared to their peers who were taught in the control group. This means that the chance to learn under the teaching and learning of SIA-TM module can have a better effect on the students' entrepreneurial science thinking. For the independent sample *t*-test, results showed that the use of the SIA-TM teaching and learning module could increase entrepreneurial science thinking more effectively compared to control group.

Exposure to the socioscientific issues in the SIA-TM module enabled students to make connections between socioscientific issues and their experiences. The discussion of socioscientific issues encourages the beginning of observation and investigation of a phenomena or situation (Darmaji et al., 2019; Kohlhauf et al., 2011). The argument made for the socioscientific issues together with the observation analysis will encourage students to observe a trend and predict situations that have not occurred or have not been witnessed (Syukri et al., 2013). This strengthens the point that the socioscientific issues approach aids students in providing an initial overview of the product to be created.

Furthermore, exposure to the socioscientific issues approach through the SIA-TM module opens a space for students to expand their knowledge on issues (Khishfe et al., 2017). In this approach, socioscientific issues are put forward in each activity unit, and presented together with examples and pictures which showed the socioscientific situations that are occurring now. The introduction to the socioscientific issues enables students to make observations based on current situations such as critical pollution. The information brought forward by these issues provides students with an input to create products that could possibly solve those socioscientific issues.

Additionally, the increase of the students' mean score who followed the SIA-TM module compared to those in the CG could be explained through the detailed step of socioscientific issues approach (Topçu et al., 2018). In the first phase of the socioscientific issues approach that introduced students to the focus of the issues, students received guidance to make early observations about the topic discussed in the issue. Then, the second phase involved making connections between scientific ideas and society's awareness, increasing observational skills among students (by asking questions in groups), connecting experiences to new discoveries, gaining new knowledge, and procuring connections between the events. The use of the socioscientific issues approach aided by the thinking wheel map increases the students' entrepreneurial science thinking skills. This is because the discussion of the issues which are expressed in the thinking wheel map can provide a clearer understanding to the students about what needs to be observed and look for answers for the issues (Mutvei et al., 2017).

The integration of the socioscientific issues approach with the thinking wheel map also encourages students to note down ideas systematically (Bengston, 2016). Any ideas that are thought of as logical and suitable with the observation, new ideas, innovation, creativity, and value constructs about the product are entered into the thinking map's stages. This facilitates students' endeavours because the stage in the wheel helps them to collect ideas speedily and systematically. The effect of this integration is proven to aid students to master the five constructs of the entrepreneurial science thinking since the thinking wheel map is easy to understand and stimulate students' systematic thinking during the brainstorming session in groups (Krueger, 2005).

The increased degree of students' entrepreneurial science thinking in the five constructs for the SIA-TM method compared to the CG method was clearly aided by the integration of the systematic SIA and TM. Researchers (Kinslow & Sadler, 2018; Sadler et al., 2017; Topçu et al., 2018) also supported the use of SIA with TM as it helps to increase the students' scientific knowledge when they explore the given socioscienctific issues. The debate of socioscientific issues leads to the debate of ideas that can expand scientific knowledge and its implication on society to ensure the students make the best decision. Following this, SIA drives students to make precise decisions in choosing the best ideas to be expanded in their product creations (Sadler & Zeidler, 2005; Zeidler, 2016; Zeidler & Nichols, 2009) and systematically expresses all this in the thinking wheel map (Bengston, 2016).

The socioscientific issues approach aided by the thinking wheel map also trains students to make decisions about social issues that involve a moral implication in a scientific context (Zeidler et al., 2003; Zeidler et al., 2005). Prior studies (Driver et al., 2000; Sadler, 2004) also agree that socioscientific issues enabled students to study and connect science with daily life and communities. This is in line with the objective of implementing entrepreneurial science thinking where students are capable of connecting science with society to create products that are compatible with societal needs and solve socioscientific issues that arise in society.

Moreover, the interview findings also proved that the use of SIA-TM module assisted students to organise ideas and expand new ideas more effectively as well as increased their STEM knowledge. Students who underwent learning through the SIA-TM module were also discovered to have enjoyed making the prototype and were more curious throughout the SIA-TM learning experience. In fact, the students also developed an awareness and responsible attitude towards their future community and teamwork in their respective teams.

In general, this study differs from past research studies in several ways. Syukri et al. (2013) who developed the module using the Entrepreneurial Science Learning Model found students' performance and enthusiasm in science learning improved, so did students' attitudes and opinions about entrepreneurship. However, Syukri et al.'s study was not intended to investigate the effects of the module on students' entrepreneurial science thinking. Mat Nawi and Tuan Soh (2018) performed research on the application of entrepreneurial science thinking. The study, on the other hand, investigated the science teachers' awareness and level of entrepreneurial scientific thinking in terms of enhancing students' creativity and innovation. Ishak et al. (2014)

investigated the readiness of science teachers from MARA Junior Science College to integrate entrepreneurial thinking into their teaching process. This research, once again, focuses on EST teaching preparation among teachers rather than on students. In comparison, very limited research has been conducted to date which concentrates on the development of modules to foster entrepreneurial science thinking among learners. The employment of a socioscientific issue approach with the use of thinking wheel map distinguishes this study.

Conclusions and Implications

The research demonstrated that the principles of using ADDIE instructional design model by integrating explicitly the constructivist learning theory, the socioscientific issues approach and thinking wheel map using Swartz and Park's integration model offer the potential for developing a SIA-TM teaching and learning module which is valid, reliable, feasible and effective in fostering entrepreneurial science thinking among fifth graders in STEM education. Students not only got to increase their level of entrepreneurial science thinking, but also improved their STEM knowledge, expansion of their ideas, sense of enjoyment and sense of teamwork. Nevertheless, this research involved only 60 Grade Five students and may not be representative of the primary school students' population as a whole. Future research will therefore need to be carried out with a larger sample size and multi-age group to assess extensively the learning effects of SIA-TM teaching and learning module on entrepreneurial science thinking.

The empirically proven ADDIE instructional design model with an integrated application of the socioscientific issues approach and thinking wheel map can be further upgraded or improved to serve as a reference model for educators who are interested in developing a learning module which fosters the science entrepreneurial thinking of different level of students. The integrated model is also a contribution to support the goal of education in many countries, that is to develop and produce globally competitive students who think critically, creatively, innovatively, and inhibit high entrepreneurial values.

Acknowledgement

The researchers would like to express their sincere gratitude to University Malaysia Sabah, Sabah, Malaysia for supporting this research under Grant No. SDN0005-2019.

Declaration of Interest

The authors declare no competing interest.

References

Ahmad, J., & Siew, N. M. (2021). Development of a children entrepreneurial science thinking test for STEM education. *Journal of Baltic Science Education*, *20*(4), 528–545. https://doi.org/10.33225/jbse/21.20.528

Ambo, N. (2019). *Kesan pembelajaran sains berasaskan projek dan pendekatan STEM terhadap lima dimensi sifat kreativiti saintifik murid tahun lima* [The effects of project-based science learning and STEM approaches on the five dimensions of scientific creativity of fifth graders]. Doctoral Thesis, Universiti Malaysia Sabah, Kota Kinabalu, Malaysia.

Bacigalupo, M., Kampylis, P., Punie, Y., & Van den Brande, G. (2016). *EntreComp: The entrepreneurship competence framework*. Publications Office of the European Union. https://doi.org/10.2791/593884

Bengston, D. N. (2016). The futures wheel: A method for exploring the implications of social–ecological change. *Society and Natural Resources*, *29*(3), 374–379. https://doi.org/10.1080/08941920.2015.1054980

Birmingham, D., & Barton, A. C. (2014). Putting on a green carnival: Youth taking educated action on socioscientific issues. *Journal of Research in Science Teaching*, *51*(3), 286–314. https://doi.org/10.1002/tea.21127

Bloom, B. S. (1956). *Taxonomy of educational objectives, Handbook 1: Cognitive domain* (2nd Ed.). David McKay Company. https://doi.org/10.1300/J104v03n01_03

Bujang, M. A., Omar, E. D., & Baharom, N. A. (2018). A review on sample size determination for Cronbach's alpha test: A simple guide for researchers. *Malaysian Journal of Medical Sciences, 25*(6), 85–99. https://doi.org/10. 21315/mjms2018.25.6.9

Branch, R. M. (2010). *Instructional design: The ADDIE approach*. Springer. https://doi.org/10.4135/9781412958806.n258

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology*, *3*(77), 77–101.

Carlton, D. J., Kicklighter, J. R., Jonnalagadda, S. S., & Shoffner, M. B. (2000). Design development and formative evaluation for adult program. *Journal of the American Dietetic Association*, *100*(5), 555–563.

Chua, Y. P. (2011). *Kaedah dan statistik penyelidikan: Kaedah penyelidikan* [Methods and research statistics: Research methods]. Mcgraw-Hill Education.

Curriculum Department Division. (2019). *Dokumen standard kurikulum dan pentaksiran Sains Tahun Lima* [Year Five science curriculum and assessment standard document]. Ministry of Education Malaysia.

Cohen, L., Manion, L., & Morrison, K. (2018). *Research methods in education*. Routledge.

Cohen, R. J., & Swedlik, M. E. 2018. *Psychological testing and assessment: An introduction to tests and measurement. Guidebook for Clinical Psychology Interns* (9th ed.). McGraw-Hill Education.

Conroy, R. (2021). *The RCSI Sample size handbook: A rough guide*. Beaumont Hospital Ethics Committee. https://www.beaumontethics.ie/docs/application/samplesize2021.pdf

Darmaji, Kurniawan, D. A., & Irdianti. (2019). Physics education students' science process skills. *International Journal of Evaluation and Research in Education*, *8*(2), 293–298. https://doi.org/10.11591/ijere.v8i2.28646

Driver, R., Newton, P., & Osborne, J. (2000). Establishing the norms of scientific argumentation in classrooms. *Science Education*, *84*(3), 287. https://doi.org/10.1002/(SICI)1098-237X(200005)84:3%3C287::AID-SCE1%3E3.0.CO;2-A

Fereday, J., & Muir-Cochrane, E. (2006). Demonstrating rigor using thematic analysis: A hybrid approach of inductive and deductive coding and theme Development. *Interdisciplinary Journal of Qualitative Methods*, *5*(1), 80–92. https://doi.org/10.1177/160940690600500107

Gay, L. R., & Airasian, P. W. (2003). *Educational research: Competencies or analysis and applications*. Prentice Hall.

Glenn, J. (1972). Futurizing teaching vs. futures courses. *Social Science Record*, *9*(3), 26–29.

Hair, J. F., Black, W. C., Babin, B. J., Anderson, R. E., & Tatham, R. L. (2006). *Multivariate data analysis* (6th Ed.). Prentice Hall.

Ho, H.-C., Wang, C.-C., & Cheng, Y.-Y. (2013). Analysis of the scientific imagination process. *Thinking Skills and Creativity*, *10*, 68–78.

Ishak, Z., Buang, N. A., & Halim, L. (2014). Ciri-ciri dan tahap pemikiran sains keusahawanan: Kesediaan integrasi pemikiran keusahawanan dalam proses pengajaran guru-guru sains di MRSM [Characteristics and level of entrepreneurial science thinking: Willingness to integrate entrepreneurial thinking in the teaching process of science teachers at MRSM]. *Jurnal Kepimpinan Pendidikan [Journal of Educational Leadership]*, *1*(1), 53–64.

Jones, M. G., & Brader-Araje, L. (2002). The impact of constructivism on education: Language, discourse, and meaning. *American Communication Journal*, *5*(3), 1–10.

Junus, I. S., Santoso, H. B., Isal, R. Y. K., & Utomo, A. Y. (2021). Usability evaluation of the student centered e-learning environment. *International Review of Research in Open and Distributed Learning*, *16*(4), 62–82. https://doi.org/https://doi.org/10.19173/irrodl.v16i4.2175

Karlsson, C., Rickardsson, J., & Wincent, J. (2021). Diversity, innovation, and entrepreneurship: Where are we and where should we go in future studies? *Small Business Economics*, *56*(2), 759–772. https://doi.org/10.1007/s11187-019-00267-1

Khishfe, R., Alshaya, F. S., BouJaoude, S., Mansour, N., & Alrudiyan, K. I. (2017). Students' understandings of nature of science and their arguments in the context of four socio-scientific issues. *International Journal of Science Education*, *39*(3), 299–334. https://doi.org/10.1080/09500693.2017.1280741

Kinslow, A. T., & Sadler, T. D. (2018). Making science relevant: Using socio-scientific issues to foster critical thinking. *The Science Teacher*, *86*(1), 40–45.

Mat Nawi, S. S., & Tuan Soh, T. M. (2018). Penerapan pemikiran sains keusahawanan dalam proses pengajaran Sains [The application of entrepreneurial science thinking in the Science teaching process]. *Prosiding Seminar Kebangsaan Majlis Dekan Pendidikan Universiti Awam* [*Proceedings of the National Seminar of the Council of Deans of Public University Education]* (pp. 7–8). https://www.unisza.edu.my/medc2018

Mutvei, A., Lönn, M., & Mattsson, J.-E. (2017, August 21-25). *Development of observation skills in science education for enhanced understanding* [Paper Presentation]. European Science Education Research Association (ESERA) Conference, Dublin, Ireland.

Nam, Y., & Chen, Y. C. (2017). Promoting argumentative practice in socio-scientific issues through a science inquiry activity. *Eurasia Journal of Mathematics, Science and Technology Education*, *13*(7), 3431–3461. https://doi.org/10.12973/eurasia.2017.00737a

Noah, S.M., & Ahmad, J. (2005). *Module development: How to develop practice module and academic module*. University Putra Malaysia.

Buang, N. A., Halim, L., & Subahan, T. M. M. (2009). Understanding the thinking of scientists entrepreneurs: Implications for science education in Malaysia. *Journal of Turkish Science Education*, *6*(2), 3–11.

Owens, D. C., Sadler, T. D., & Zeidler, D. L. (2017). Controversial issues in the science classroom. *Phi Delta Kappan*, *99*(4), 45–49. https://doi.org/10.1177/0031721717745544

Pascual-Leone, J., & Johnson, J. (2005). A dialectical constructivist view of developmental intelligence. *Handbook of Understanding and Measuring Intelligence*, 177–201.

Piaget, J. (1976). Piaget's theory. In *Piaget and His School* (pp. 11–23). https://doi.org/10.1007/978-3-642-46323-5_2

Rahman, M.S.A. (2020). *Pendekatan berasaskan sosio-saintifik berbantukan peta pemikiran masa hadapan terhadap lima konstruk pemikiran masa hadapan pelajar* [The socio-scientific-based approach helped with future thinking map on the five constructs of students' future thinking]. Doctoral Thesis, Universiti Malaysia Sabah, Kota Kinabalu, Malaysia.

Saavedra, A. R., & Opfer, V. D. (2012). Learning 21st-century skills requires 21st-century teaching. *Phi Delta Kappan*, *94*(2), 8–13. https://doi.org/10.1177/003172171209400203

Sadler, T. D. (2004). Informal reasoning regarding socioscientific issues: A critical review of research. *Journal of Research in Science Teaching*, *41*(5), 513–536. https://doi.org/10.1002/tea.20009

Sadler, T. D., & Zeidler, D. L. (2005). The significance of content knowledge for informal reasoning regarding socioscientific issues: Applying genetics knowledge to genetic engineering issues. *Science Education*, *89*(1), 71–93. https://doi.org/10.1002/sce.20023

Sadler, T. D., Foulk, J. A., & Friedrichsen, P. J. (2017). Evolution of a module for socio-scientific issue teaching and learning. *International Journal of Education in Mathematics Science and Technology*, *5*(2), 75–87.

Sekaran, U., & Bougie, R. (2010). *Research methods for business: A skill building approach* (5th ed.). John Willey & Sons.

Sjøberg, S. (2007). Contructivism and learning. In *International Encyclopaedia of Education* (3rd ed.). Elsevier. https://doi.org/10.1134/S1061933X16060144

Swartz, R. J., & Parks, S. (1994). *Infusing the teaching of critical and creative thinking into content instruction: A lesson design handbook for the elementary grades*. Critical Thinking Books and Software.

Syukri, M., Halim, L., & Meerah., T.S.M. (2013). *Pendidikan STEM dalam entrepreneurial science thinking "ESciT": Satu perkongsian pengalaman dari UKM untuk Aceh* [STEM education in entrepreneurial science thinking "ESciT": An experience shared from UKM for Aceh]. *Aceh Development International Conference, 2013*, 105–112.

Taherdoost, H. (2016). Validity and reliability of the research instrument; How to test the validation of a questionnaire/survey in a research study. *International Journal of Academic Research in Management*, 5(3), 28–36.

Topçu, M. S., Foulk, J. A., Sadler, T. D., Pitiporntapin, S., & Atabey, N. (2018). The classroom observation protocol for socioscientific issue-based instruction: development and implementation of a new research tool. *Research in Science & Technological Education*, *36*(3), 302–323. https://doi.org/10.1080/02635143.2017.1399353

Vygotsky, L. (1978). *Mind in society: The development of higher psychological processes*. Harvard University Press. https://doi.org/10.1016/S0140-6736(10)60669-1

Yurdugül, H. (2008). Minimum sample size for Cronbach's coefficient alpha: A Monte Carlo study. *Hacettepe Egitim Dergisi*, *35*, 397–405.

Zeidler, D. L. (2016). STEM education: A deficit framework for the twenty first century? A sociocultural socioscientific response. *Cultural Studies of Science Education*, *11*(1), 11–26. https://doi.org/10.1007/s11422-014-9578-z

Zeidler, D. L., & Nichols, B. H. (2009). Socioscientific issues: Theory and practice. *Journal of Elementary Science Education*, *21*(2), 49–58. https://doi.org/10.1007/bf03173684

Zeidler, D. L., Sadler, T. D., Applebaum, S., & Callahan, B. E. (2009). Advancing reflective judgment through socioscientific issues. *Journal of Research in Science Teaching*, *46*(1), 74–101. https://doi.org/10.1002/tea.20281

Zeidler, D. L., Sadler, T. D., Simmons, M. L., & Howes, E. V. (2005). Beyond STS: A research-based framework for socioscientific issues education. *Science Education*, *89*(3), 357–377. https://doi.org/10.1002/sce.20048

Zeidler, D. L. & Keefer, M. (2003). *The role of moral reasoning on socioscientific issues and discourse in science education*. Kluwer Academic.

Appendix

Stage	The Task	Sample Answers	STEM Element
Observation			
1 (a)	State the materials used to make the car.	i. Iron and aluminium for the body of the car ii. Rubber for tires iii. Plastic for car interior materials.	**Science [S]** i. An energy source is needed to power a car. **Technology [T]** i. Fuel system - supplies petrol or diesel to the engine.
1 (b)	State the design of the car.	i. Aerodynamic design ii. Round and square lamp. iii. Different car body styles – jeep, van, sedan etc	
1 (c)	State the features found on the car.	i. The fossil fuel used is a non-renewable energy ii. Fuel combustion system iii. Side and tail mirrors reflect light behind a driver. iv. Use of GPS and Bluetooth technology in cars.	

New Ideas			
2 (a)	Explain the advantages of using the specified materials to make a car.	i. The material is readily available. ii. Lightweight material is suitable for car manufacturing. iii. Appropriate costs.	**Science [S]** i. The principle of light - can be reflected on flat, hard and shiny surfaces. ii. GPS technology allows users access to live route maps.
2 (b)	Explain the advantages of using the stated car design.	i. Less air resistance. ii. Cars can move fast. iii. The car looks stylish.	
2 (c)	Explain the advantages of using the features available on the car.	i. Energy sources are readily available. ii. Energy resources can be obtained at affordable costs. iii. The use of mirrors and technology in the car facilitates the user while driving and keeps the driver in a safe condition. iv. Burning fuel to produce energy.	
Innovation			
3 (a)	Choose 3 ideas that can be modified or improved.	i. Consumption of fossil fuel. ii. Burning fuel to produce energy. iii. Car design.	
3 (b)	Make an evaluation of the selected ideas.	i. Can be modified to meet the future of modernity ii. Fuel combustion can be replaced with more energy -efficient methods. iii. Can be modified to be more environmentally friendly.	
Creativity			
4 (a)	Sketch and label 3 features for a future car.	i. Aerodynamic and modern design, the use of durable materials. ii. Water is used as an energy source to produce hydrogen. iii. Use of water hydrolysis technology, GPS navigation, safety operator assistance system	**Science [S]** Hydrogen vehicles for better fuel economy than conventional vehicles. **Technology [T]** i. Water hydrolysis technology: cars use water and car batteries to generate electrical energy. **Engineering [E]** i. Sketching a car. **Mathematics [M]** i. Set the price for the prototype according to market price. ii. Estimate the speed of the car. Speed =
4 (b)	State the name of the product, the price offered and the target group of buyers.	i. Any logical answer is acceptable	

Value			
5 (a)	State the benefits of the product to society from the aspect of cost savings.	i. Car prices are lower. ii. Cars are affordable for many people. iii. The use of water can save fuel costs.	**Science [S]** i. Energy efficiency = x 100 ii. Cultivation of life practices and sustainable use of materials.
5 (b)	State the benefits of the product to society from the aspect of product function.	i. The car is safe to drive even on potholed roads. ii. Cars make it easier for users to reach their destinations. iii. The durable car body makes it safer.	
5 (b)	State the benefits of the product to society from the aspect of values and ethics in product creation.	i. Renewable energy consumption. ii. Maximum energy efficiency use. iii. Cars do not pollute the environment.	

Received: *December 25, 2021*　　　Accepted: *February 05, 2022*

Cite as: Ahmad, J., & Siew, N. M. (2022). An entrepreneurial science thinking module based on the socioscientific issues approach with thinking wheel map for primary school students in STEM education. *Problems of Education in the 21st Century*, *80*(1), 30-51. https://doi.org/10.33225/pec/22.80.30

Jamilah Ahmad	MEd. (Science Education), PhD Candidate, Faculty of Psychology and Education, University of Malaysia Sabah, 88400, Kota Kinabalu, Sabah, Malaysia. E-mail: jamilahahmad99@gmail.com ORCID: https://orcid.org/0000-0003-0555-550X
Nyet Moi Siew *(Corresponding author)*	PhD, Associate Professor, Faculty of Psychology and Education, University of Malaysia Sabah, 88400, Kota Kinabalu, Sabah, Malaysia. E-mail: sopiah@ums.edu.my ORCID: https://orcid.org/0000-0003-1989-5863

This is an open access article under the
Creative Commons Attribution 4.0
International License

IMPACT OF EXPERIENCING EVENT DESIGN WITH WEB 2.0 TOOLS ON PROSPECTIVE MATHEMATICS TEACHERS

Aybige Arabaci, Keziban Orbay
Amasya University, Turkey
E-mail: aybige9045@gmail.com, keziban.orbay@amasya.edu.tr

Abstract

In this study, the impact of activity designing experiences with Web 2.0 tools on prospective math teachers was examined. The aim of the study was to examine the impact of activity design experiences organized with Web 2.0 tools in the mathematics teaching course on the technological pedagogical content efficacy of prospective teachers, their attitude towards teaching technologies, and rapid content development self-efficacy with Web 2.0 tools. In the study, a nested mixed method was employed. In the study conducted with 33 prospective teachers from the primary mathematics teaching department, the quantitative data was collected using the scales "Technological Pedagogical Content Knowledge", "Self-Sufficiency for Web 2.0 Rapid Content Development" and "Attitude to Teaching Technologies". Qualitative data was collected using an interview form. Within the scope of the distance education and "Teaching numbers" course, different Web 2.0 tools were introduced for a period of 10 weeks, and it was presented how to create activity examples that could be used in mathematics teaching. According to the quantitative results, the prospective mathematics teachers' self-efficacy increased for rapid content development with Web 2.0 tools. In addition, it was observed that the "Attitude towards Teaching Technologies" scale had a significant effect on the sub-dimensions such as believing in the use of teaching technologies in lessons, enjoying the use of teaching technologies in lessons, and not enjoying the use of teaching technologies. In line with the opinions of prospective mathematics teachers, it was concluded that the study raised awareness about technology integration, enabled content production with Web 2.0 tools, and developed positive attitudes, new knowledge, and skills about technology.
Keywords: *mathematics education, teaching numbers, distance education, teaching technology, web 2.0 tools.*

Introduction

Today, rapid development and changes in information and communication technologies have affected many areas as well as educational environments which include the process of creating, structuring, and adapting information to daily life. These rapid changes and variations in technology and education have led teachers to think about the arrangements they need to implement to best prepare students for the 21st century (Solomon & Schrum, 2007), and technology integration in modern societies has become the basic need expected of teachers (Teo, 2009). Accordingly, prospective teachers should be prepared by teacher trainers in a way to transfer their knowledge to digital natives and the internet generation in 21st century classrooms (Kumar & Vigil, 2011). In order for technology to be integrated in accordance with education, teachers need to be able to integrate information and communication technologies into their content and pedagogical knowledge without problems.

One of the factors affecting the use of technology in prospective teachers' future professional lives is the knowledge and skills they develop during undergraduate education (Anthony & Clark, 2011; Niess, 2005; Özgün Koca, 2009). Therefore, teacher training programs should offer prospective teachers the opportunity to develop skills, strategy and awareness required to plan an effective education enriched with technology in their professional lives

https://doi.org/10.33225/pec/22.80.52

(Niess, 2008), and these programs should offer the opportunity to experience rich educational experiences for prospective teachers who do not have sufficient experience in planning and using educational technologies in teaching (Kovalik et al., 2013), although they can comfortably use technology for social networking, communication and entertainment in their personal lives (Niess, 2008).

Teacher trainers, who are the best predictors to combine pedagogy, self-sufficiency and beliefs with technology in their classrooms, need to improve preliminary knowledge and existing perceptions of prospective teachers in courses and professional development teaching provided (Wilson et al., 2005). Web 2.0 tools, which are one of the best technologies that can be integrated into education today, offer teachers alternative digital applications that can enable their professional development without time and space restrictions (Dalgarno & Lee, 2010). Yusop (2015) indicated that researchers focus on factors that influence the use of Web 2.0 technologies by educators, and that educators' beliefs, intentions and attitudes towards technology are important determinants for future successful technology integration. Accordingly, it will be useful to see the reflection of technology-assisted teachings that will improve field knowledge, self-proficiency perception and attitudes of prospective mathematics teachers.

Web 2.0 technologies are tools that enable individuals to create content on the web and collaborate by eliminating geographical and temporal differences (O'reilly, 2007). Although these technologies were not originally designed for education, they offer both collaborative learning and individual learning opportunities for students (Hsu et al., 2014). Their use in the classroom not only promotes structuring learning, but also expands the content of traditional teaching and forms the bridge between theory and practice (Clark et al, 2009). Web 2.0 activates the student by providing opportunities such as information creation, production, editing and evaluation, and improves their self-confidence (McLoughlin & Lee, 2007). In addition, the correct and appropriate use of these tools in education can excite and encourage students to learn as they raise awareness of group work and improve their collaboration skills (Crook, 2012; Mason & Rennie, 2007).

Ensuring that students are willing to learn and evaluate through various activities is one of the main characteristics of successful math teachers. Web 2.0 tools provide teachers with significant opportunities for this. Web 2.0 tools commonly used in education include ToonyTool (cartoon app), Popplet (concept map app), Cram (game app), Quiver (augmented reality app), Learning Apps (various educational games app), Padlet (digital dashboard app), Toontastic (cartoon and animation app), Storyjumper (digital story and magazine app), Prezi (presentation app), Quizizz (evaluation app), Plickers (evaluation app) and The Math Learning Center (math applications). These Web 2.0 tools allow teacher to input data and produce multimedia products using text, audio, video, and graphics, limiting creativity and diversity. However, it is also very important to check the quality of the content created with these applications. Erroneous and low-quality content will not be effective in achieving the desired success in education.

The 5E model developed by Rodger Bybee, which is also recommended in this study, is one of the most effective teaching models included in the constructivist approach. It consists of five steps. These steps are Engage, Explore, Explain, Elaborate, and Evaluate, respectively. Each step has a certain function in itself. Each step provides opportunities to help the teacher improve learning activities and guide students through the learning process (Bybee et al., 2006).

Literature Review

Examining the field literature, there are studies aimed towards determining prospective teachers' opinions and intentions regarding the use of Web 2.0 tools (Bozkurt & Cilavdaroğlu, 2011; Chiou, 2011; Dalim et al., 2019; Erduran, 2019; Günbaş & Yıldız, 2020; Korucu et al., 2015; Kul & Çelik 2018; Lim & Newby, 2020; Özçakır & Aydın, 2019; Özpınar, 2017; Pala & Erdem, 2015; Sadaf et al., 2012; Say & Yildirim, 2020; Virtanen & Rasi, 2017). These studies generally focus on all prospective teachers and a single type of application in field-specific studies, not specific to the field. For this reason, it is important to plan a pre-service training that will contribute to the development of technological pedagogical knowledge in the field of mathematics, which is compatible with the curriculum and will serve different purposes, and that allows gaining experience in designing activities. Habre and Grundmeier (2007) have indicated in their study that prospective teachers' experiences with the use of technology are important, and that their inadequate experience can influence their views on integrating technology into mathematics and prevent them from becoming aware of their own potential in a pedagogical sense. Many researchers have suggested that it is the responsibility of the teacher training programs to gain technological experience that will enable prospective teachers to increase their field knowledge, skills and beliefs in integrating technology into mathematics and to understand how to use it in mathematics teaching (Agyei & Voogt, 2012; Erdogan & Sahin, 2010; Hofer & Grandgenett, 2012; Niess, 2005; Sadaf et al., 2012). Technology integration will be needed more because distance education is continued instead of face-to-face education during the Covid-19 pandemic, and online education will be a part of education after this process. For this reason, it is of great importance to examine the impact of the experiences of prospective teachers who will implement future curricula on them in developing and implementing materials to support online education. In this context, the impact of the experience of designing course activities using Web 2.0 tools suitable for the 5E model of prospective math teachers on their field competencies was examined in this study. Thus, in the context of the intended teaching, it will be revealed how the skills and perceptions of prospective math teachers to effectively integrate technology and pedagogy are affected. This study is unique to the field of mathematics, covers many Web 2.0 applications, and includes an experience of designing activities in accordance with the curriculum.

Research Aim and Research Questions

The study is based on the question "Does experiencing event design using Web 2.0 tools in accordance with model 5E have an impact on some field qualifications of prospective math teachers?" Accordingly, the answers to the following questions were searched:

With regard to the application of mathematics teaching course activities organized with Web 2.0 tools in accordance with the 5E model;

RQ1. What is the impact on prospective teachers' levels of Self-Efficacy towards Web 2.0 Rapid Content Development (SEW2RCD) and its dimensions?

RQ2. What is the impact on prospective teachers' levels on Technological Pedagogical Content Knowledge (TPCK) and its dimensions?

RQ3. What is the impact on prospective teachers' levels on Attitude towards Teaching Technologies (ATT) and its dimensions?

RQ4. What is the impact on the opinions of prospective teachers?

Research Methodology

Pattern

The study was conducted using the nested mixed method, one of the mixed research patterns. Many data types from nested mixed methods, either quantitative or qualitative, were collected and used together sequentially or simultaneously, and they were used in a way to support each other (Creswell, 2014). In the quantitative part, a single-group pre-test-final test pattern was preferred, and in the qualitative part, a case study approach was preferred. In the fall semester of the 2020-2021 academic year, preliminary tests were first performed and then trainings were carried out. Subsequently, the course plans prepared by the participants were evaluated, feedbacks were made, and final tests were applied. Finally, a structured interview was conducted.

Study Group

In the fall semester of the 2020-2021 academic year, the study was carried out with 33 prospective teachers in the 3rd grade of the Elementary Mathematics Teaching program at a public university. It was accepted that prospective teachers could carry out activities within the scope of the study and had the necessary pedagogical foundations due to the Teaching Technologies, Teaching Principles and Methods, Mathematics Learning and Teaching Approaches, Secondary School Mathematics Curricula, Information Technologies and Computer Aided Mathematics Teaching courses they received in previous periods. Due to the complete interruption of face-to-face training during the Covid-19 process, technological infrastructure deficiencies in the targeted groups and limited number of participants in the research, the number of participants was small. This situation is indicated in limitations section. Taking into account ethical understanding, the names of the participants are encoded as "PT1, PT2, PT3,…". Demographic characteristics of participants are presented in Table 1.

Table 1
Demographic Background of the Participants

	Category	Frequency (f)	Percent (%)
Gender	Female	29	87.9
	Male	4	12.1
Academic Achievement	70-74	4	12.1
	75-79	13	39.4
	80-84	11	33.3
	85-90	5	15.2
Internet Access Tool	Computer Mobile phone	3 30	9.1 90.9

It is seen from Table 1 that 87.9% of the participants are women, their academic average is concentrated in the range of 75-79, and 90.9% access the Internet by mobile phone.

Data Collection Tools

In the collection of quantitative data**,** the following scales were used: the SEW2RCD scale developed by Birişçi et al. (2018) in order to establish the self-sufficiency beliefs of prospective teachers in rapid content development with Web 2.0 tools at different stages of the course; the Technological Pedagogical Content Knowledge (TPCK) scale developed by Schmidt et al. (2009) in order to determine the levels of technological pedagogical content knowledge and adapted to mathematics and Turkish by Dikkartın Övez and Akyüz (2013); Attitude to Teaching Technologies (ATT) scale developed by Metin et al. (2012). The Cronbach Alpha reliability coefficients of the scales used are 0.955 for the SEW2RCD scale, 0.91 for the TPCK scale and 0.949 for the ATT scale. The interview form created to collect qualitative data was developed to describe the data obtained from quantitative data collection tools and analysis of course plans. The interview form was prepared by a math teacher who used Web 2.0 applications in his courses, taking into account the scales used and monitoring the teaching process. It was then examined and arranged by two field experts and finalized. The absence of a relationship of interest with the participants, long-term interaction and return to the prepared activities constituted an environment of trust. The data were gathered according to ethical guidelines for qualitative and quantitative research including the informed participant consent, guaranteed anonymity, and confidentiality.

Application

The study was carried out for 10 weeks within the scope of "Teaching Numbers" course in the 2020-2021 academic year. Due to the Covid-19 pandemic, the subjects in "teaching numbers" curriculum were explained by the faculty member who carried out the course during distance education, and videos prepared by the researcher with related examples were shown to the students at the end of the course every week. Since the courses were also recorded in the university's distance education system, it was also possible to monitor these courses afterwards. In these videos, prospective teachers were presented with information about the use of 12 Web 2.0 tools that addressed different stages of mathematics teaching, how to create activities and how to integrate them into teaching.

Data Analysis

In the study, quantitative data analysis was carried out with SPSS 20.0 packaged software. Shapiro-Wilk test, Skewness and Q-Q graph were taken into account for the hypothesis of normality. "Dependent t-test" was used to examine the significance of the difference between pre-test and post-test averages. Cohen's d formula was used for dependent t-test and the magnitude of the effect was calculated when the difference between averages was significant. The data obtained from the interview form was analysed by content analysis method. The reliability formula developed by Miles and Huberman (1994) was used to determine the reliability of the data obtained. Reliability was found to be 100% in the theme, 88.8% in categories and subcategories, and 95% in encodings.

Research Results

Results on RQ1 are presented in Table 2.

Table 2
Prospective Teachers' SEW2RCD and Sub-dimensions Dependent Sample t-test Results

SEW2RCD Scale and Sub-Dimensions		***n***		***SD***	***df***	***t***	***p***	**Cohen's *d***
SEW2RCD	Pre-test	33	3.09	.72	32	-5.321	<.005	.926
	Post-test	33	3.94	.56	32			
Preparation	Pre-test	33	2.95	.71	32	6.227	<.005	1.084
	Post-test	33	3.90	.57	32			
Presentation	Pre-test	33	3.43	.98	32	1.931	>.005	
	Post-test	33	3.81	.64	32			
Evaluation	Pre-test	33	3.22	.83	32	4.999	<.005	.870
	Post-test	33	4.21	.71	32			

When the arithmetic averages of the SEW2RCD scale for preparation, presentation and evaluation sub-dimensions were examined for prospective teachers before and after application, it was seen that there was an increase. It can be seen that this increase was statistically significant in SEW2RCD (-5.321), preparation (6.227) and evaluation (4.999), and considering the magnitude of effect, SEW2RCD (Cohen's *d*=0.926>0.8), preparation (Cohen's *d*=1.084>0.8) and evaluation (Cohen's *d*=0.870>0.8) had a significant effect. The increase in the subdivision of Presentation (1.931) is not statistically significant.

Results on RQ2 are presented in Table 3.

Table 3
Prospective Teachers' TPCK and Sub-dimensions Dependent Sample t-test Results

TPCK Scale and Sub-Dimensions		*n*		*SD*	*df*	*t*	*p*
TPCK	Pre-test	33	3.58	.46	32	-1.135	>.005
	Post-test	33	3.67	.38			
Technology Knowledge	Pre-test	33	3.42	.62	32	.649	>.005
	Post-test	33	3.48	.60	32		
Mathematics Knowledge	Pre-test	33	3.56	.48	32	1.081	>.005
	Post-test	33	3.66	.53	32		
Mathematics Teaching Information	Pre-test	33	3.62	.62	32	.344	>.005
	Post-test	33	3.66	.53	32		
Mathematics Teaching Technology Information	Pre-test	33	3.66	.49	32	1.348	>.005
	Post-test	33	3.80	.40	32		

When the arithmetic averages of prospective teachers before and after the application of TPCK scale and sub-dimensions such as Technology Knowledge, Mathematics Knowledge, Mathematics Teaching Information and Mathematics Teaching Technology Information were examined, there was an increase, but this increase was not statistically significant considering the results of the dependent sample t-test.

Results on RQ3 are presented in Table 4.

Table 4
Prospective Teachers' ATT and Sub-dimensions Dependent Sample t-test Results

ATT Scale and Sub-Dimensions		*n*		*SD*	*df*	*t*	*p*	Cohen's *d*
ATT	Pre-test	33	3.13	.27	32	-1.450	>.005	
	Post-test	33	3.19	.20				
Believing in the Use of Teaching Technologies in Courses	Pre-test	33	3.93	.57	32	2.549	<.005	.443
	Post-test	33	4.15	.49	32			
Enjoying the Use of Teaching Technologies in Courses	Pre-test	33	3.56	.59	32	2.794	<.005	.486
	Post-test	33	3.83	.42	32			
Distaste for the Use of Teaching Technologies	Pre-test	33	1.95	.42	32	-2.791	<.005	.485
	Post-test	33	1.76	.45	32			
Being Reluctant to Use Teaching Technologies	Pre-test	33	2.59	.37	32	-.872	>.005	
	Post-test	33	2.52	.33	32			
Believing in the Benefits of Teaching Technologies	Pre-test	33	4.30	.57	32	.584	>.005	
	Post-test	33	4.36	065	32			

When the arithmetic averages of prospective teachers before and after the application of the ATT scale were examined, it was seen that there was an increase in the positive sub-dimensions such as Believing in the Use of Teaching Technologies in Courses, Enjoying the Use of Teaching Technologies in Courses and Believing in the Benefits of Teaching Technologies, that there was a decrease in Distaste for the Use of Teaching Technologies and Being Reluctant to Use Teaching Technologies negative sub-dimensions. It can be seen that this change was statistically significant in Believing in the Use of Teaching Technologies in Courses (2.549), Enjoying the Use of Teaching Technologies in Courses (2.794) and Distaste for the Use of Teaching Technologies (2.791), and considering the magnitude of effect, Believing in the Use of Teaching Technologies in Courses (Cohen's d=0.443<0.5), Distaste for the Use of Teaching Technologies (Cohen's d=0.485<0.5) and Enjoying the Use of Teaching Technologies in Courses (Cohen's d=0.486<0.5) had a small effect. In ATT (-1.450), Being Reluctant to Use Teaching Technologies (-0.872) and Believing in the Benefits of Teaching Technologies (0.584), the change was not statistically significant.

The results of RQ4 were examined under three main themes including *contributions*, *difficulties encountered,* and *the use of Web 2.0 tools* based on codes determined from prospective teachers' answers to the questions in the interview form related to designing course activities. Categories, subcategories, and codes related to the "*Contribution*" theme are shown in Table 5.

Table 5
Contributions of the Process of Designing Course Activities

Category	Sub-Category		Frequency (*f*)	Percent (%)
Mathematics Teaching	Technology Integration	Awareness	18	26.87
		Learning How to Use It	8	11.94
		Learning the Field of Use	1	1.49
		Ability to Produce Content	5	7.46
	Pedagogical Content Knowledge	Different Narration Methods	3	4.48
		Research Skills	4	5.97
		Measurement and Assessment	1	1.49
Technology Use		New Knowledge and Skills Development	8	11.94
		Positive Attitude	9	13.43
		Self-confidence	6	8.96
		Saving Time	4	5.97

It is seen that the most important contribution of the process of designing course activities was awareness about technology integration, which is the subcategory of mathematics teaching. Prospective teachers indicated that they learned the function and opportunities of integrating technology into mathematics teaching, in which way, in which part of the course, and how often they will use the tools they chose. For example, the answer by PT6 is given below.

> *PT6: "When I was preparing the lesson plan, I realized for myself. Even the word file, which we consider the simplest and often use only for writing, has many functions and benefits for us to use in the course. Thanks to web 2.0 tools, I have seen that I can prepare and use many fun and useful content that I can use to enrich the course in an easy and interesting way using technology."*

In the Pedagogical Content Knowledge subcategory in the mathematics teaching category, it was seen that the most important contribution was on research skills. Prospective teachers have indicated that the process of designing activities provided an increase in research skills, use of different narrative methods, and increase in knowledge of measurement and evaluation. As an example, Prospective Teacher 1 gave the following answer:

> *PT1: "The contribution of these tools, which simplistically simplistic technology for education, was that the only way to explain the course was to contribute to the course, which I could realize with more active student participation, contrary to the familiar methods."*

In the category of the use of technology, it can be seen that the most important contribution was in positive attitude and new knowledge and skills development. Prospective teachers stated that they developed a positive attitude in the use of technology in the event preparation process, gained new knowledge and skills, gained confidence, and saved time. The answer given by PT18 is quite remarkable.

> *PT18: "I thought it was very difficult to create games and events in these programs. In fact, I loved it so much that I created activities and games other than what I put in my lesson plan. I am going to use it a lot in my life."*

Encodings related to the theme "Challenges Encountered" is shown in Table 6.

Table 6
Challenges of Designing Course Activities

	Frequency (*f*)	Percent (%)
5E Model Stages	3	8.33
Appropriate Narration Method	4	11.11
Conceptual Knowledge and Narration	2	5.56
Time Distribution	3	8.33
Resource Discovery	2	5.56
Preparing a Question	6	16.67
Activity	12	33.33
Content Determination	2	5.56
Appropriate Web 2.0 Tool Selection	2	5.56

It is seen that the most difficult situation is in activity preparation. The answer of PT10 reflects the opinion of most prospective teachers.

> *PT10: "I can say that one of the points I am struggling with is the act of 'generating activity'. It really forced me to think of a safe, fun and instructive activity that was educationally useful, suitable for the functioning of the program, aimed at student achievements. I still do not feel comfortable with some of the activities I use. I know it is hard not only for me, but for all my friends, since our goal here is to have an event that can both have fun and teach, rather than a random event."*

Categories and codes of the theme "Using Web 2.0 Tools" are shown in Table 7.

Table 7
Use of Web 2.0 Tools in the Process of Designing Course Activities

Category		Frequency (*f*)	Percent (%)
Tools Deemed Sufficient (Top 5)	LearningApps	14	13.46
	ToonyTool	12	11.54
	Quizizz	12	11.54
	Toontastic	11	10.58
	Cram	10	9.62
Tools Deemed Insufficient (Top 5)	Story Jumper	5	27.78
	Popplet	3	16.67
	Padlet	2	11.11
	Prezi	2	11.11
	Plikers	2	11.11
Preferred Tools (Top 5)	Learning Apps	16	34.04
	ToonyTool	10	21.28
	Quizizz	7	14.89
	Cram	3	6.38
	Toontastic	2	4.26
In the Implementation Process Phase Used	Introduction	7	14.29
	Discovering	6	12.24
	Explanation	6	12.24
	Deepening	14	28.58
	Evaluation	16	32.65
Using in Professional Life	Yes	33	100

It can be seen that the tools that prospective teachers consider themselves most adequate are Learning Apps, Toonytool and Quizizz, respectively, and the tools that prospective teachers consider themselves insufficient are Storyjumper and Popplet, respectively. In the process of designing course activities, the tools they consider sufficient are more than the tools they consider themselves inadequate. At the same time, it was determined that 4 of the vehicles deemed sufficient were tools that were not introduced to prospective teachers during the implementation process. Learning Apps, ToonyTool and Quizizz are also the most preferred tools for prospective teachers in the process of designing course activities, and the stages they use most are evaluation and deepening.

Discussion

The design process of mathematics teaching course activities has had an impact on the SEW2RCD of prospective teachers. Qualitative results obtained in line with the opinions of prospective teachers also support this thesis. It has been determined that the tools that prospective teachers consider themselves sufficient in the process of designing course activities are more than the tools they consider themselves inadequate, and four of the tools deemed sufficient are tools that are not introduced to prospective teachers during the implementation process. Based on this, it is possible to suggest that prospective teachers have increased their self-sufficiency for Web 2.0 tools. When the literature is examined, there are studies that the experience of teaching technology integration courses, content development and event preparation using Web 2.0 tools increases teachers' self-sufficiency in learning and implementing teaching technologies (Gursoy & Goksun, 2019; Onbaşılı, 2020; Overbaugh & Lu, 2008)

The design process of mathematics teaching course activities has improved all dimensions of the SEW2RCD scale for prospective teachers, while having more impact on the sub-dimensions of "Preparatory" and "Assessment". In their studies with prospective classroom and science teachers using the same scale, Gursoy and Goksun (2019) and Onbaşılı (2020) suggested that the experiences of prospective teachers using Web 2.0 tools had a meaningful effect on all dimensions of the SEW2RCD scale. Although this study's results regarding the sub-dimensions of "Preparation" and "Evaluation" are in line with these studies, they do not match the results regarding the sub-dimension of "Presentation". Considering the qualitative results, it has been determined that prospective teachers used web 2.0 tools in the "Introduction", "Deepening" and "Evaluation" stages in their course plans, and this situation served the sub-dimensions of "Preparation" and "Evaluation". Alhassan (2017) and Ward (2015) stated that there was a strong relationship between the use of Web 2.0 tools in classrooms and Web 2.0 tools self-proficiency beliefs. Therefore, it is expected that prospective teachers will develop self-sufficiency at the stages where they use Web 2.0 tools more.

There has been an increase in prospective mathematics teachers' TPCK levels and sub-dimensions before and after application, but this increase was not statistically significant. Analysing the studies suggesting that the processes carried out within the scope of training, courses, projects, etc. have improved at TPCK levels of prospective teachers (Agyei & Voogt, 2012; Araujo & Gadanidis, 2020; Bhagat et al., 2017; Hardy, 2010; Koyunkaya, 2017; Kul et al., 2019; Niess, 2005), it was observed that collaborative, active discussion environments were provided both face-to-face and online for prospective teachers, and they were offered the opportunity to apply in the teaching environment. The Covid-19 pandemic has restricted the study researchers from providing all the aforementioned opportunities to prospective teachers in this study conducted with distance education. Moreover, since pedagogy and technology can be best organized with collaborative studies in the classroom environment (Bull et al., 2007; Koehler & Mishra, 2007); it may be possible that a significant increase could not be achieved in TPCK levels of prospective teachers.

Since not only scales are sufficient in measuring TPCK but it should be supported by multiple data sources (Abbitt, 2011; Agyei & Keengwe, 2014; Lyublinskaya & Tournaki, 2015), when qualitative results are examined, it is observed that the process of designing course activities has contributed to "awareness", "learning the way of use", "content reproducing", "new knowledge and skills development" and "self-confidence" for prospective mathematics teachers. It can be said that prospective teachers' gaining awareness has positively affected TPCK levels in the process of designing mathematics activity. The ability to produce the content that prospective teachers will apply to their lesson plans indicates that they have improved in terms of technology integration, while their confidence in the use of technology and gaining new knowledge and skills indicates that they have developed in terms of technology knowledge. In this case, it can be suggested that this study is effective in the development of TPCK levels of prospective teachers. Thompson (2007) has indicated that, thanks to the advantages of Web 2.0 tools and their useful interfaces, users can produce content without difficulty. For this reason, in this study, ensuring that prospective teachers are aware of the mathematical activities that can be created with Web 2.0 tools may have improved prospective teachers' perception of being able to produce content.

Prospective teachers have difficulty in preparing lesson plans. Considering that pedagogical content knowledge is defined as the ability to select and effectively organize teaching strategies and practices specific to the subject content to be taught (Mishra & Koehler, 2006), it is seen that prospective teachers have difficulties in the pedagogical content knowledge dimension.

Considering the entire ATT scale, this increase was not statistically significant, although there was an increase in ATT levels when the design process of mathematics teaching course activities and the attitude of prospective teachers towards teaching technologies were taken into account before and after implementation. It was observed that there was an increase in the sub-dimensions of the ATT scale that measure positive attitudes and a decrease in negative sub-dimensions. Virtanen and Rasi (2017) also suggested that prospective teachers developed a positive perspective on integrating Web 2.0 tools into the course by integrating Web 2.0 applications into the “Problem-Based Learning” course, aiming to reveal the experiences and opinions of prospective teachers through case study.

Conclusion and Implications

It was concluded that the process of designing math activity with Web 2.0 tools has an impact on prospective teachers’ SEW2RCD levels. Considering the sub-dimensions of the SEW2RCD scale, it was found that it was not effective in the “Presentation” sub-dimension, but it was effective on the sub-dimensions, “Preparation” and “Evaluation”. In line with the opinions of prospective teachers, it was concluded that the tools they consider sufficient in the process of designing course activities are more than the tools they consider inadequate. It was concluded that prospective teachers may have high perceptions of SEW2RCD due to the fact that prospective teachers voluntarily learn and try new Web 2.0 tools outside of those introduced during the design process. Prospective teachers found themselves most inadequate in presentation tools, and they were all willing to use Web 2.0 tools in their professional lives.

The design process of mathematics teaching course activities did not have a meaningful impact on TPCK and all sub-dimensions of prospective teachers. However, prospective teachers gained awareness about the function and opportunities of technology in mathematics teaching. Integrating technology into mathematics teaching, prospective teachers learned how to use the tools, in which part of the course and how often, they were able to produce content with Web 2.0 tools, they developed new knowledge, skills and a sense of self-confidence about the use of technology. However, prospective teachers have difficulty in creating creative, engaging and stage-appropriate activities that are suitable for the student level. At the same time, it has been found in the study that prospective teachers have difficulty in preparing questions that are appropriate to students’ levels, offer a variety of questions, make use of acquisitions well, make connection between students’ preliminary information and the information they have just learned, and determine the appropriate narrative method that will allow the subject to be better conveyed in accordance with the students’ readiness and individual differences. In addition, the time distribution and the 5E model are among the situations where prospective teachers have difficulty in applying.

Considering the entire ATT scale, although the design process of mathematics teaching course activities showed no effects on prospective teachers’ attitudes towards teaching technologies, when sub-dimensions of this scale were examined, *the belief in the use of teaching technologies* and *enjoyment of the use of teaching technologies* were positively affected. The arithmetic average of the entire scale and a sub-dimension measuring positive attitude increased, although not significantly. There has been a decrease in arithmetic averages of the sub-dimension that measures negative attitude, although not significantly. In addition, considering prospective teachers’ average scores from the ATT scale and its sub-dimensions before the application, it was observed that prospective teachers used to have a moderate and good positive attitude before the application. Therefore, this may explain why the increase after the application is statistically significant. Considering the qualitative results, the vast majority of prospective teachers stated that the study process contributed to the use of technology, and they gained a positive attitude.

Since the use of technology in education is now a must with the Covid-19 pandemic process, teachers should be given in-service training related to the use of Web 2.0 tools to prepare for situations that may be needed such as the pandemic process, and by integrating teaching technologies into the different curricula of faculty members working in education faculties, it can be ensured that prospective teachers are aware of various Web 2.0 tools that serve different purposes and achievements. In the future, including Web 2.0 tools, studies can also be carried out on the examination of some field qualifications of prospective teachers using a blended teaching method that combines distance education with face-to-face education, or by using technology-assisted micro-teaching applications. Similar studies can be done comparatively for teachers and prospective teachers. This study was carried out within the scope of "Teaching Numbers" course. The change can also be examined within the scope of “Geometry Teaching” course.

Limitations

This research is limited to 33 teacher candidates who studied in the third year of Primary Mathematics Teaching at a public university in the 2020-2021 academic year and took the course “Teaching numbers”. In addition, the teaching process is limited to a total of 10 weeks of distance education.

Ethical Approval

The data were gathered according to ethical guidelines for qualitative research including informed participant consent, guaranteed anonymity, and confidentiality (The Unit of Ethics of Amasya University with Reference Number 674).

Declaration of Interest

Authors declare no competing interest.

Acknowledgments

The authors would like to thank the anonymous referees for their encouraging comments and insightful suggestions, which helped to improve the quality of the research substantially.

References

Abbitt, J. T. (2011). Measuring technological pedagogical content knowledge in preservice teacher education: A review of current methods and instruments. *Journal of Research on Technology in Education, 43*(4), 281-300. https://doi.org/https://doi.org/10.1080/15391523.2011.10782573

Agyei, D. D., & Keengwe, J. (2014). Using technology pedagogical content knowledge development to enhance learning outcomes. *Education and Information Technologies, 19*(1), 155-171. https://doi.org/https://doi.org/10.1007/s10639-012-9204-1

Agyei, D. D., & Voogt, J. (2012). Developing technological pedagogical content knowledge in pre-service mathematics teachers through collaborative design. *Australasian Journal of Educational Technology, 28*(4), 547-564. https://doi.org/https://doi.org/10.14742/ajet.827

Alhassan, R. (2017). Exploring the relationship between Web 2.0 tools self-efficacy and teachers' use of these tools in their teaching. *Journal of Education and Learning, 6*(4), 217-228. https://doi.org/http://doi.org/10.5539/jel.v6n4p217

Anthony, A. B., & Clark, L. M. (2011). Examining dilemmas of practice associated with the integration of technology into mathematics classrooms serving urban students. *Urban Education, 46*(6), 1300-1331. https://doi.org/https://doi.org/10.1177/0042085911416015

Araujo, R. C., & Gadanidis, G. (2020). Online collaborative mind mapping in a mathematics teacher education program: A study on student interaction and knowledge construction. *ZDM, 52*(5), 943-958. https://doi.org/https://doi.org/10.1007/s11858-019-01125-w

Bhagat, K. K., Chang, C.-Y., & Huang, R. (2017). Integrating GeoGebra with TPACK in improving pre-service mathematics teachers' professional development. 2017 IEEE 17th International Conference on Advanced Learning Technologies (ICALT).

Birişçi, S., Kul, Ü., Aksu, Z., Akaslan, D., & Çelik, S. (2018). A scale development study to determine Web 2.0 practical content development self-efficacy belief (W2SEBS). *Educational Technology Theory and Practice Journal, 8*(1), 187-208. https://doi.org/https://doi.org/10.15345/iojes.2019.01.014

Bozkurt, A., & Cilavdaroğlu, A. K. (2011). Mathematics and classroom teachers' perceptions of technology use and integration into their instruction. *Kastamonu Education Journal, 19*(3), 859-870. https://dergipark.org.tr/en/pub/kefdergi/issue/49049/625724

Bull, G., Park, J., Searson, M., Thompson, A., Mishra, P., Koehler, M. J., & Knezek, G. (2007). Developing technology policies for effective classroom practice. *Contemporary Issues in Technology and Teacher Education, 7*(3), 129-139. https://www.learntechlib.org/primary/p/26276/.

Bybee, R. W., Taylor, J. A., Gardner, A., Van Scotter, P., Powell, J. C., Westbrook, A., & Landes, N. (2006). *The BSCS 5E instructional model: Origins and effectiveness*. https://media.bscs.org/bscsmw/5es/bscs_5e_full_report.pdf

Chiou, Y.-F. (2011). *Perceived usefulness, perceive ease of use, computer attitude, and using experience of Web 2.0 applications as predictors of intent to use Web 2.0 by pre-service teachers for teaching* (Publication Number 3466156) [Ph.D., Ohio University]. ProQuest Dissertations & Theses Global. Ann Arbor. https://www.proquest.com/dissertations-theses/perceived-usefulness-perceive-ease-use-computer/docview/901907862/se-2?accountid=25074

Clark, W., Logan, K., Luckin, R., Mee, A., & Oliver, M. (2009). Beyond Web 2.0: Mapping the technology landscapes of young learners. *Journal of computer assisted learning, 25*(1), 56-69. https://doi.org/https://doi.org/10.1111/j.1365-2729.2008.00305.x

Creswell, J. W. (2014). Nitel, nicel araştırma deseni ve karma yöntem yaklaşımları [Qualitative, quantitative research design and mixed method approaches] (S. B. Demir, Çev. Ed.). Eğiten Kitap.

Crook, C. (2012). The 'digital native' in context: Tensions associated with importing Web 2.0 practices into the school setting. *Oxford Review of Education, 38*(1), 63-80. https://doi.org/https://doi.org/10.1080/03054985.2011.577946

Dalgarno, B., & Lee, M. J. (2010). What are the learning affordances of 3-D virtual environments? *British Journal of Educational Technology, 41*(1), 10-32. https://doi.org/https://doi.org/10.1111/j.1467-8535.2009.01038.x

Dalim, S. F., Azliza, N. Z. M., Ibrahim, N., Zulkipli, Z. A., & Yusof, M. M. M. (2019). Digital storytelling for 21st century learning: A study on pre-service teachers' perception. *Asian Journal of University Education, 15*(3), 226-234. https://doi.org/https://doi.org/10.24191/ajue.v15i3.7801

Dikkartin Övez, F. T., & Akyüz, G. (2013). Modelling technological pedagogical content knowledge constructs of preservice elementary mathematics teachers. *Education and Science, 38*(170), 321-334. http://dspace.balikesir.edu.tr/xmlui/bitstream/handle/20.500.12462/9128/filiz-tuba.pdf?sequence=2&isAllowed=y

Erdogan, A., & Sahin, I. (2010). Relationship between math teacher candidates' technological pedagogical and content knowledge (TPACK) and achievement levels. *Procedia-Social and Behavioral Sciences, 2*(2), 2707-2711. https://doi.org/https://doi.org/10.1016/j.sbspro.2010.03.400

Erduran, A. (2019). Pre-service mathematics teachers' views on formative valuation with Web 2.0 tools: Kahoot! example. In *International Symposium of Turkish Computer and Mathematics Education*. İzmir.

Gursoy, G., & Goksun, D. O. (2019). The experiences of pre-service science teachers in educational content development using Web 2.0 tools. *Contemporary Educational Technology, 10*(4), 338-357. https://doi.org/https://doi.org/10.30935/cet.000000

Günbas, N., & Yıldız, H. (2020). Use of Edmodo social networking website in mathematics curriculum class: Pre-service teachers’ views. *Journal of Bayburt Education Faculty, 15*(29), 109-129. https://doi.org/https://doi.org/10.35675/befdergi.478788

Habre, S., & Grundmeier, T. A. (2007). Prospective mathematics teachers' views on the role of technology in mathematics education. *Issues in the Undergraduate Mathematics Preparation of School Teachers, 3*. http://files.eric.ed.gov/fulltext/EJ835509.pdf

Hardy, M. D. (2010). Facilitating growth in preservice mathematics teachers' TPCK. *National Teacher Education Journal, 3*(2), 121-138. https://www.researchgate.net/publication/282877535

Hofer, M., & Grandgenett, N. (2012). TPACK development in teacher education: A longitudinal study of preservice teachers in a secondary MA Ed. program. *Journal of research on Technology in Education, 45*(1), 83-106. https://doi.org/ttps://doi.org/10.1080/15391523.2012.10782598

Hsu, Y., Ching, Y., & Grabowski, B. L. (2014). Web 2.0 applications and practices for learning through collaboration. In *Handbook of research on educational communications and technology* (pp. 747-758). Springer. https://doi.org/https://doi.org/10.1007/978-1-4614-3185-5_60

Koehler, M. J., Mishra, P., & Yahya, K. (2007). Tracing the development of teacher knowledge in a design seminar: Integrating content, pedagogy and technology. *Computers & Education, 49*(3), 740-762. https://doi.org/https://doi.org/10.1016/j.compedu.2005.11.012

Korucu, A., Korucu, A. T., & Çakır, H. (2015). The opinions of the teacher candidates using collaborative learning environment developed via dynamic web technologies. *Adiyaman University Journal of Social Sciences*, (19), 221-254. https://doi.org/https://doi.org/10.14520/adyusbd.61147

Kovalik, C., Kuo, C.-L., & Karpinski, A. (2013). Assessing preservice teachers' information and communication technologies knowledge. *Journal of Technology and Teacher Education, 21*(2), 179-202. https://www.learntechlib.org/primary/p/40634/

Koyunkaya, M. Y. (2017). A teaching experiment that aims to develop pre-service mathematics teachers’ technological pedagogical and content knowledge. *Turkish Journal of Computer and Mathematics Education, 8*(2), 284-322. https://doi.org/https://doi.org/10.17762/turcomat.v8i2.157

Kul, U., Aksu, Z., & Birisci, S. (2019). The relationship between technological pedagogical content knowledge and Web 2.0 self-efficacy beliefs. *Online Submission, 11*(1), 198-213. https://files.eric.ed.gov/fulltext/ED593344.pdf

Kul, Ü., & Çelik, S. (2018). Investigating changes in mathematics teachers’ intentions regarding web 2.0 technology integration. *Acta Didactica Napocensia, 11*(2), 89-104. https://files.eric.ed.gov/fulltext/EJ1185876.pdf

Kumar, S., & Vigil, K. (2011). The net generation as preservice teachers: Transferring familiarity with new technologies to educational environments. *Journal of Digital Learning in Teacher Education, 27*(4), 144-153. https://doi.org/https://doi.org/10.1080/21532974.2011.10784671

Lim, J., & Newby, T. J. (2020). Preservice teachers’ Web 2.0 experiences and perceptions on Web 2.0 as a personal learning environment. *Journal of Computing in Higher Education, 32*(2), 234-260. https://doi.org/https://doi.org/10.1007/s12528-019-09227-w

Lyublinskaya, I., & Tournaki, N. (2015). Examining the relationship between self and external assessment of TPACK of pre-service special education teachers. In L. Liu, & D. Gibson (Eds.), *Research Highlights in Technology and Teacher Education 2015.* AACE – Association for the Advancement of Computing in Education.

Mason, R., & Rennie, F. (2007). Using Web 2.0 for learning in the community. *The Internet and Higher Education, 10*(3), 196-203. https://doi.org/10.1016/j.iheduc.2007.06.003

McLoughlin, C., & Lee, M. (2007). Social software and participatory learning: Pedagogical choices with technology affordances in the Web 2.0 era. ICT: Providing choices for learners and learning. In R. Atkinson, C. McBeath, & A. Soong Swee Kit (Eds.), *ICT: Providing choices for learners and learning. Proceedings ASCILITE Singapore 2007* (pp. 664-675). Centre for Educational Development.

Metin, M., Kaleli Yilmaz, G., Coskun, K., & Birisci, S. (2012). Developing an attitude scale towards using instructional technologies for pre-service teachers. *Turkish Online Journal of Educational Technology-TOJET, 11*(1), 36-45. https://files.eric.ed.gov/fulltext/EJ976568.pdf

Miles, M. B., & Huberman, A. M. (1994). *Qualitative data analysis: An expanded sourcebook*. Sage.

Mishra, P., & Koehler, M. J. (2006). Technological pedagogical content knowledge: A framework for teacher knowledge. *Teachers College Record, 108*(6), 1017-1054. http://one2oneheights.pbworks.com/f/MISHRA_PUNYA.pdf

Niess, M. L. (2005). Preparing teachers to teach science and mathematics with technology: Developing a technology pedagogical content knowledge. *Teaching and Teacher Education, 21*(5), 509-523. https://doi.org/https://doi.org/10.1016/j.tate.2005.03.006

Niess, M. L. (2008). Guiding preservice teachers in developing TPCK. In M. C. Herring, M. J. Koehler, & P. Mishra (Eds.), *Handbook of technological pedagogical content knowledge (TPCK) for educators* (pp. 223-250). AACTE Committee on Innovation and Technology. New York: Routledge for the American Association of Colleges for Teacher Education.

O'reilly, T. (2007). What is Web 2.0: Design patterns and business models for the next generation of software. *Communications & Strategies* (1), 17.

Onbaşılı, Ü. I. (2020). The effects of science teaching practice supported with Web 2.0 tools on prospective elementary school teachers' self-efficacy beliefs. *International Journal of Progressive Education, 16*(2), 91-110. https://files.eric.ed.gov/fulltext/EJ1249937.pdf

Overbaugh, R., & Lu, R. (2008). The impact of a NCLB-EETT funded professional development program on teacher self-efficacy and resultant implementation. *Journal of Research on Technology in Education, 41*(1), 43-61. https://files.eric.ed.gov/fulltext/EJ810574.pdf

Özçakır, B., & Aydın, B. (2019). Effects of augmented reality experiences on technology integration self-efficacy of prospective mathematics teachers. *Turkish Journal of Computer and Mathematics Education, 10*(2), 314-335. https://doi.org/https://doi.org/10.16949/turkbilmat.487162

Özgün Koca, S. A. (2009). The views of preservice teachers about the strengths and limitations of the use of graphing calculators in mathematics instruction. *Journal of Technology and Teacher Education, 17*(2), 203-227. https://www.learntechlib.org/primary/p/26268/

Özpınar, İ. (2017). Preservice mathematics teachers' opinions on the use of digital stories and instructional environments. *Bartin University Journal of Faculty of Education, 6*(3), 1189-1210. https://doi.org/https://doi.org/10.14686/buefad.340057

Pala, F. K., & Erdem, M. (2015). Opinions of pre-service teachers on online discussion environments. *Turkish Online Journal of Qualitative Inquiry, 6*(2), 24-47. https://doi.org/https://doi.org/10.17569/tojqi.12373

Sadaf, A., Newby, T. J., & Ertmer, P. A. (2012). Exploring pre-service teachers' beliefs about using Web 2.0 technologies in K-12 classroom. *Computers & Education, 59*(3), 937-945. https://doi.org/https://doi.org/10.1016/j.compedu.2012.04.001

Say, S., & Yildirim, F. S. (2020). Investigation of pre-service teachers' Web 2.0 rapid content development self-efficacy belief levels and their views on Web 2.0 tools. *International Journal of Educational Methodology, 6*(2), 345-354. https://doi.org/https://doi.org/10.12973/ijem.6.2.345

Schmidt, D. A., Baran, E., Thompson, A. D., Mishra, P., Koehler, M. J., & Shin, T. S. (2009). Technological pedagogical content knowledge (TPACK) the development and validation of an assessment instrument for preservice teachers. *Journal of Research on Technology in Education, 42*(2), 123-149. https://files.eric.ed.gov/fulltext/EJ868626.pdf

Solomon, G., & Schrum, L. (2007). *Web 2.0: New tools, new schools*. International Society for Technology Education.

Teo, T. (2009). Examining the relationship between student teachers' self-efficacy beliefs and their intended uses of technology for teaching: A structural equation modelling approach. *Turkish Online Journal of Educational Technology-TOJET, 8*(4), 7-15. https://files.eric.ed.gov/fulltext/EJ859493.pdf

Thompson, J. (2007). Is Education 1.0 ready for Web 2.0 students? *Innovate: Journal of Online Education, 3*(4). https://www.learntechlib.org/p/104227/

Virtanen, J., & Rasi, P. (2017). Integrating web 2.0 technologies into face-to-face PBL to support producing, storing, and sharing content in a higher education course. *Interdisciplinary Journal of Problem-Based Learning, 11*(1), 5. https://doi.org/https://doi.org/10.7771/1541-5015.1613

Ward, S. (2015). The impact of self-efficacy and professional development on implementation of web 2.0 tools in elementary classrooms. https://digitalcommons.gardner-webb.edu/education_etd/140

Wilson, P. S., Cooney, T. J., & Stinson, D. W. (2005). What constitutes good mathematics teaching and how it develops: Nine high school teachers' perspectives. *Journal of Mathematics Teacher Education*, *8*, 83–111. https://doi.org/10.1007/s10857-005-4796-7

Yusop, F. D. (2015). A dataset of factors that influence preservice teachers' intentions to use Web 2.0 technologies in future teaching practices. *British Journal of Educational Technology, 46*(5), 1075-1080. https://doi.org/10.1111/bjet.12330/abstract

Received: *December 28, 2021* Accepted: *February 08, 2022*

Cite as: Arabaci, A., & Orbay, K. (2022). Impact of experiencing event design with web 2.0 tools on prospective mathematics teachers. *Problems of Education in the 21st Century*, *80*(1), 52-68. https://doi.org/10.33225/pec/22.80.52

Aybige Arabacı *(Corresponding author)*	MSc, Mathematics Education Department, Faculty of Education, Amasya University, Amasya, Turkey. E-mail: aybige9045@gmail.com ORCID: https://orcid.org/ 0000-0002-4912-5782
Keziban Orbay	PhD, Professor, Head of Mathematics Education Department, Faculty of Education, Amasya University, Amasya, Turkey. E-mail: keziban.orbay@amasya.edu.tr ORCID: https://orcid.org/ 0000-0002-7642-4139

This is an open access article under the
Creative Commons Attribution 4.0
International License

PROBLEMS
OF EDUCATION
IN THE 21st CENTURY
Vol. 80, No. 1, 2022

PROSPECTIVE PRE-SCHOOL TEACHERS' VIEWS ON STEM LEARNING IN GRADE 9: THE PRINCIPLE OF CONTINUITY IN EDUCATION

Dagnija Cedere, Inese Jurgena, Rita Birzina, Sandra Kalnina
University of Latvia, Latvia
E-mail: dagnija.cedere@lu.lv, inese.jurgena@lu.lv,
rita.birzina@lu.lv, sandra.kalnina@lu.lv

Abstract

The life quality of society and the stability of national economy is largely connected with science, technology, engineering, and mathematics (STEM). The complex character of STEM education demands informed teaching/learning strategies in order to make the 21st century youth interested in learning. The aim of the research was to find out the views of prospective pre-school teachers on Grade 9 students' STEM learning, thus addressing the topical principle of continuity in education. A survey of 261 prospective pre-school teachers of the University of Latvia was performed. The obtained results show that in general the prospective pre-school teachers have some notion about the level of teaching/learning requirements in Grade 9 of the basic school, the integration of STEM and teaching/learning strategies. They acknowledge cognitive interest, inquiry-based learning and the importance of STEM knowledge and skills in the national development as significant, but little value is given to the exploration of nature in out-of-school time and to the importance of mathematical skills. More experienced respondents assess STEM learning higher. The given research raises the issue of the principle of continuity in education and gives a possibility to understand better the needs of prospective teachers in order to improve teacher education programs at the University.

Keywords: *cognitive interest, continuity of education, prospective pre-school teachers, STEM learning*

Introduction

Science, technology, engineering, and mathematics (STEM) is an important part of general education that constitutes the necessary people's knowledge and skills of our future society. Therefore, the teaching/learning process has to be organized in such a way that the child's/learner's development proceeds through successive stages of education, and the learning is harmonized according to the principle of continuity in its broadest sense. Positive experience in the field of STEM gained in early childhood serves as a basis for further meaningful STEM education. Lately, the idea that children's early education – a stage before the primary education – lays foundation for lifelong learning and development (Eurydice Report, 2019) has been actualized.

Research Problem

Science, technology, engineering, and mathematics education is important for learners to succeed in future. Implementing STEM education there are more possibilities to help learners to develop relevant topical skills: critical thinking, problem solving, decision making, learning to learn, communication, collaboration, teamwork (Barcelona, 2014; Binkley et al., 2012;

https://doi.org/10.33225/pec/22.80.69

Maass et al., 2019; Tytler, 2020). STEM education has grown significantly since 2007, and a closer bond has developed among the STEM subjects, especially emphasizing 'the real life' context (Takeuchi et al. 2020), reciprocally connecting science, technology, engineering, and mathematics, as well as making connections between school, community, work, and the global enterprise enabling the development of STEM literacy and with it the ability to compete in the new economy (Tsupros et al., 2009). This means that the impact of STEM education can be viewed in the aspect of economics, politics, and culture (Hom, 2014), as well as common rationales for science education - the utilitarian: science knowledge needed for everyone, and the democratic: political and moral dilemmas of the contemporary society are of a scientific nature (Osborne & Hennessy, 2003).

Integrated STEM education is one of the ways how to make learning more attractive and appropriate for learners (Stohlmann et al., 2012). However, it is still difficult to ensure that students are able to see the link among these subjects and to help them understand that information, processes and practice that are connected with these subjects are combined and used in the process of solving the real-life problems (Dass, 2015; Kelley & Knowles, 2016). This means that one of the main reasons why students lose interest to acquire STEM is that, in general, the learning process seems boring to students which does not foster effective learning (Martínez-Borreguero et al., 2019). Motivating and engaging context, student-centered learning, focusing on teamwork and communication, can be considered the main elements of integrated STEM education (Moore et al., 2015). The more hands-on activities are used in the teaching/learning process, the more students' inquiry skills will be developed: to formulate the hypothesis, to experiment, to draw conclusions and to think analytically. Inquiry-based learning supported by information communication technology (Fiksl et al., 2017) increases students' interest. Inquiry-based learning is recognized as a very perspective model of active science teaching and learning, emphasizing that such studies need the interdisciplinary approach both in the empirical and theoretical fields, thus, ensuring better understanding (Gajić et al., 2021). Besides, the use of hands-on, active learning strategies in the teaching/learning process makes learning and the acquisition of knowledge easier (Martínez-Borreguero et al., 2019).

National education reform has been implemented in Latvia since 2020. Regarding the science domain, it takes place in four aspects: the promotion of cooperation in the acquisition of the teaching/learning content, the use of information and communication technologies (ICT) as a platform for developing reasoning and problem solving, experiential learning, which focuses on the process of discovery, and discussion-based teaching, which situates knowledge in the political and cultural context (Andersone, 2020).

Studies in Latvia have found that students of Grade 9 have a rather low level of cognitive interest in science, the majority of students have no desire to make any effort. A great part of students do not consider science and mathematics knowledge as personally relevant (Jurgena et al., 2018). This means that students' skills in these subjects need to be improved to increase their interest in continuing education in the fields in which they will have to acquire knowledge and skills important for the entrepreneurship and labor market, and which are more perspective in the context of future economics (NAP, 2020).

Research Focus

Continuity is one of the most important principles in pedagogy. Continuity is a concept which is used to describe 'the course of events, procedure of processes, transition of features, etc. that ensure the continuation, preservation of work, traditions and views of previous generations, predecessors and their further development in the life of the new generation, the formation of a similar social identity', as well as 'successive connection with something prior, a definite transition which observes the succession from the nearest to the farthest, from the understandable to the incomprehensible, from the easiest to more difficult, from unknown to the known, also gradualness' (Belickis et al., 2000, p. 125). The principle of continuity is employed in developing the teaching/learning curricula, Carr and Kemmis (2003) have explained it as a transition from one stage of education to the next, from the unknown to the known, as respect to the peculiarities of human development stages.

The nature of the principle of continuity is based on the philosophical ideas of Dewey about the connection of interaction and continuity (experience and education) with the quality of education. In one of his most famous articles on education, Dewey (1986, p. 12) has shared thoughts about the relations between experience and education, claiming that there is an organic link between experience and education because all experiences absorb something from the previous ones and transform the quality of experience which comes from them (Dewey, 1986, p. 27). It has been maintained that for the experience to have some educational value it must establish the growth, which creates further advancement. Therefore, education is the means of life, of social continuity (Dewey, 1997). Dewey (1986, p. 2) has postulated that growth which is defined as physical, intellectual, and moral development is the example of the principle of continuity.

Implementing changes in pre-school education and improving the quality of early childhood education, the necessity is actualized to focus, especially, on the early childhood stage (McCall, 2017; Vallberg-Roht, 2020) because a part of children, who now start attending the pre-school, will probably be employed in such jobs that do not exist yet (NAP, 2020). It is considered that it is possible to reach successful readiness of children or development of their adaptation skills in the transition from pre-school to school applying the mechanisms of complementing, which are understood as enriching and adding children's experience and knowledge to the instrumental social and cognitive priorities. For instance, academic learning is added to the game, children are asked to be responsible for success (Babic, 2017).

The principle of continuity actualizes correlations of theoretical thinking and productive imagination of the cognitive process of children's learning. Creative thinking is the basis of pre-school children's theoretical thinking therefore, the unity of productive imagination and creative thinking serves as a basis for the continuity between pre-school and school (Davydov & Kudriavtsev, 1998), especially regarding the development of the content of the curricula and the ways of teacher collaboration for improving the quality of children's learning and teaching.

Lately, the number of studies about STEM education is rapidly increasing, however, little attention is paid to the STEM field at pre-school age (Takeuchi et al., 2020). Yet, the use of diverse practical and interesting science activities to develop children's inquiry skills and to promote their cognitive interest is highly recommended in pre-school education, and it is important to pay attention to exactly this level of societal education which can be a crucial contribution to increasing the population's scientific literacy and achievement (Brenneman, 2011).

Children possess immense inquisitiveness, thirst for knowledge and the skill to ask questions. The inquiry activity characteristic to a child fosters the development of inquisitiveness and inquiry activity. Children want to discover, explore, and understand the world and themselves. The task of early childhood teachers is to promote this curiosity ensuring relevant learning experience and engaging environment in the pre-school education institution (Howitt et al., 2011).

Children already in early childhood should be encouraged to observe different nature phenomena and to gain ideas about what is happening around, thus developing their curiosity about the world and obtaining knowledge in STEM fields. This means that ensuring positive experience in STEM education already in early childhood it is possible to promote cognitive interest about STEM, forming the conviction that they can gain success in STEM fields in future (Çiftçi et al., 2020). STEM education should be implemented as early as possible because it helps children to develop scientific knowledge and form their scientific thinking. It is important that exact sciences are incorporated in the teaching/learning process in the way that corresponds to children's level of development. STEM education, certainly, is a challenge for very young children; teacher's task in this context is to make a link between 'ordinary' knowledge (knowledge about 'the real world') and scientific knowledge, between 'playing' and 'learning at school' (Surma et al., 2019).

Since September 1, 2020, comprehensive schools of Latvia have been gradually introducing curricula according to the new competence-based pre-school, basic and general secondary education standards, thus developing knowledge, skills, and attitudes necessary for the 21st century (National Reforms in School Education, 2020). The principle of continuity has been followed in developing the teaching/learning content. Students during the basic education stage Grades 1 – 6 acquire natural sciences in an integrated science subject and starting with Grade 7 in separate subjects – chemistry, physics, biology, and geography (Skola2030, 2019a). The aim of pre-school education is an inquisitive, creative, and joyful child who lives a healthy, safe, and active life, acts independently, learns with interest and joy gaining experience about oneself, others, the surrounding world, and the mutual interaction in it. Natural sciences in the pre-school curriculum, too, are very closely connected with mathematics and technology domains (Skola2030, 2019b, 2019c).

Research Aim and Research Questions

The new competence-based teaching/learning content of Latvia (National Reforms in School Education, 2020) connects the separate stages of general comprehensive education into a common, successive system, starting with the pre-school. Such a reciprocally coordinated approach is especially important in STEM education in order to initiate children's inquisitiveness already in pre-school so that later it grows into genuine cognitive interest. Therefore, the teacher of every stage of education has, to a certain extent, to be informed about the teaching/learning in the next stage of education. Grade 9 is the end of primary education and is often used to diagnose STEM learning achievements, so pre-school teachers' perceptions of STEM learning were focused on Grade 9.

The aim of the study was to find out the views of prospective pre-school teachers about STEM learning of Grade 9 students, thus also addressing the topical principle of continuity of education.

The following research questions were set:

1. What are prospective pre-school teachers' views about STEM learning?
2. How do prospective pre-school teachers understand STEM learning in the context of Grade 9?

Research Methodology

General Background

Studies performed in Latvia are indicative of the low prestige of STEM education – the knowledge level of secondary school graduates in science and mathematics often is not sufficient for continuing their education (Birzina et al, 2021a), young adults' interest about STEM is low (Cedere et al., 2018). These factors, hindering the national development, actualize the study about STEM learning which is based on the idea about the continuity of education. Young adults' level of knowledge and attitude in the STEM field are closely connected with the teachers' professional competence, thus education of good teachers is also topical (NAP, 2020).

The study is based on the survey of prospective pre-school teachers with the aim of finding out their views about STEM learning, focusing on pre-school teachers' awareness of STEM learning at the end of the next stage of education - in Grade 9. The survey connects two different stages of education, drawing prospective pre-school teachers' attention to the level of learning requirements in Grade 9. Thus, skills and attitudes characteristic to the STEM field are viewed in the context of continuity of education.

The survey was carried out in autumn of 2021.

Sample

The study has involved first year students of the University of Latvia - prospective pre-school teachers. The total number of first year students studying to become pre-school teachers was 306, of them 261 or 85% participated in the survey. This sample that reflects the characteristics of the entire student group was representative to consider the survey reliable and to arrive at valid conclusions.

Almost all the participants were women, namely 259, and 2 were men, which is less than 1%. All respondents were part-time students and represented different regions of Latvia, of them 26% studied in Riga, and 74% - in one of the seven regional branches of the University of Latvia.

The average age of respondents was 33 years, the age bracket being 19-57 years. It is important to mention that 30% of respondents, mainly older students, who want to obtain the teacher qualification, have already work experience with pre-school children.

In order to make a comparison according to the respondents' age group and more obvious, three age groups were established: Group A (19-30 years), Group B (31-40 years), and Group C (41 and more) (Table 1).

Table 1
Distribution of Respondents per Age Group

Group	Age (years)	*N*	%
A	19-30	99	38
B	31-40	115	44
C	41 -57	47	18
Total	19-57	261	100

Instrument and Procedures

The study used a survey in which prospective pre-school teachers expressed their views about STEM learning. The questionnaire was developed based on the previous studies (Cedere et al., 2018) and in compliance with the normative documents in Latvia (National Reforms in School Education, 2020).

The questionnaire comprises 21 close-ended questions on 4- point Likert scale (from 1 – *fully disagree* to 4 – *fully agree*) and 5 open questions. The closed questions are subordinated to the common basic question: *How should Grade 9 students answer the given questions according to education provisions and national needs?* Questions that are given in a mixed order include also two learning aspects – the learning process (Block A) and cognitive interest (Block B). Block A comprises questions that describe the learning skills and attitudes and Block B contains questions from different STEM subjects that are thematically connected with nature exploration and everyday life. The reliability (inter-item consistency) of the questionnaire according to

Cronbach’s alpha coefficient was .87. The previous studies (Cedere et al., 2018) confirm the validity of the questionnaire.

The questionnaire was made using google.doc. Students filled in the questionnaire on-line. Students’ participation in the survey was voluntary, the anonymity of the survey was guaranteed.

Data Analysis

The Cronbach's alpha test was used to determine the internal consistency of the questionnaire.

Indicators of descriptive statistics – mean and standard deviation were used to describe the empirical data. Applying one sample Kolmogorov-Smirnov test, it was established that the distribution of empirical data did not correspond to the normal distribution ($p < .005$) therefore non-parametric statistical methods were used in the data analysis. Spearman rank correlation was used to define the degree of association between two variables. The Kruskal-Wallis *H* test was used to compare three independent groups.

Research Results

The learning content connected with practical life and nature, inquiry skills and attitude were used in the questionnaire to describe Grade 9 students’ attitudes to STEM. Prospective pre-school teachers answered the questions of the questionnaire showing their understanding of the general education model currently existing in Latvia and remembering their school years.

Table 2 presents summarized data about Block A questions that describe respondents’ views about the anticipated Grade 9 students’ attitude to STEM, about skills acquired at school as well as the learning intensity. Mean values of answers are arranged in increasing order.

Table 2
STEM Learning of Grade 9 Students: Views of Prospective Pre-school Teachers

No	Items	Variables	*M*	*SD*
1	A11	Exploration in the leisure time	2.40	0.81
2	A5	Problem-solving skill	2.80	0.66
3	A8	Enthusiasm, perseverance	2.87	0.84
4	A4	The skill to analyze	2.98	0.67
5	A3	The skill to explain	2.98	0.72
6	A10	Overcoming difficulties	3.14	0.78
7	A9	Interest resulting from inquiry	3.20	0.72
8	A13	Understanding about the importance of STEM	3.53	0.67

$1 \leq M \leq 4$

Answers of prospective pre-school teachers showed that they acknowledged inquiry skills, including the skill to analyze and evaluate, as important. They valued equally highly the perseverance in learning and not being afraid of difficulties. These, certainly, are important in the process of learning STEM.

The importance of STEM knowledge in the national development is valued the highest (A13, $M = 3.53$, $SD = 0.67$), it points to the homogeneity of views and at the same time describes prospective teachers' good understanding of the new education model in Latvia. Grade 9 students are expected to develop interest in the process of exploration (A9), though meaning with it the performance in lessons. The relatively low values of standard deviations in these questions also indicate a rather big consensus of respondents.

Exploration in the leisure time is evaluated the lowest (M = 2.40). Respondents' distribution showed that 14% *fully disagree*, and 35% respondents – *rather disagree*, which together constitutes almost half of the total number of respondents.

Views of prospective pre-school teachers on the desirable Grade 9 students' cognitive interest are reflected in Table 3, which summarizes the data about Block B questions. Mean values of answers are arranged in increasing order.

Table 3
Cognitive Interest in STEM of Grade 9 Students: Views of Prospective Pre-school Teachers

No		Variables	*M*	*SD*
1	B8	Liked to use mathematical equations in solving practical tasks	2.26	0.87
2	B5	Willingness to understand why the soap solution is not clear	2.98	0.96
3	B4	Interest in using modified organisms	3.19	0.83
4	B6	Willingness to find out why the glass container breaks if water freezes in it	3.34	0.83
5	B3	Interest in the structure and functions of the human organism	3.48	0.68
6	B1	Interest why the air after the thunderstorm smells differently	3.55	0.71
7	B7	Willingness to know how drinking water is purified	3.59	0.62

$1 \leq M \leq 4$

In general, prospective pre-school teachers considered the cognitive interest important. Besides, there are no sharp differences among respondents' answers ($SD < 1$) in this block of answers, too, which proves that the majority of respondents have similar views. Respondents' views differed depending on the content of the question and STEM thematic field. High school students' interest is anticipated about the question related to what is happening in the nature – the smell of the air after the thunderstorm because without delving into the requirements for Grade 9 the question seems very simple (B1). Equally high interest is foreseen if the question is connected with the purification of drinking water (B7), which is important from the point of view of daily life. High cognitive interest is envisaged also about daily processes if they are connected with biology, chemistry or physics. However, much lower interest is anticipated if the task is connected with mathematics (B8, $M = 2.26$, $SD = 0.87$).

Comparison of Prospective Teachers' Views Depending on Their Life Experience

The Kruskal Wallis H Test was performed to find out if the differences in prospective teachers' views can be linked to their life experience. Respondents' answers were compared according to the three age groups. The obtained results showed that the answers given by respondents of different age groups to the majority of questions were similar and there were no statistically significant differences among them. Only results that demonstrate significant differences among age groups are summarized in Table 4.

Table 4
Differences in Views of Prospective Pre-school Teachers Depending on Their Age

Items	**Group A** (*n*=99) (age 19-30 years)		**Group B** (*n*=115) (age 31-40 years)		**Group C** (*n*=47) (age 40+ years)		χ^2	*df*	*p*
	M	SD	M	SD	M	SD			
A11	2.20	0.82	2.53	0.79	2.51	0.78	10.162	2	.006
A13	3.39	0.75	3.64	0.55	3.55	0.69	6.345	2	.042
B3	3.43	0.70	3.44	0.68	3.68	0.63	6.622	2	.036
B4	3.03	0.85	3.25	0.80	3.38	0.80	7.517	2	.023

As seen in Table 4, the prospective teachers with greater life experience (Group B and Group C), value higher cognitive activities in time free from school (A11). They better understand learning outcomes in Grade 9 that also include deep enough knowledge in biology – knowledge about human organism (B3) and about the use of modified organisms (B4). Group B has the highest conviction about the importance of STEM knowledge in the national development (A13), where the dispersion of answers is small ($M = 3.64$; $SD = 0.55$).

Didactic Connection among STEM Subjects

In order to establish what connection is among separate characteristic features of STEM teaching and learning, the correlation analysis according to Spearman's correlation coefficients was performed. Using the whole sample of respondents, only weakly statistically significant correlations were found, but such a result was of little information. Using the variable *'like mathematics'* (B8), for which the mean value of answers was the lowest, respondents were selected who had answered '*fully agree*' about mathematics, thus with a potentially good understanding about STEM learning. A group of 19 respondents was separated (7.3% of the total number), for which the correlation analysis was performed according to 7 most important STEM learning criteria (Table 5).

Table 5
Correlations among Variables that Describe STEM Learning

Variables	**A3**	**A4**	**A5**	**A6**	**A8**	**A10**	**A13**
The skill to explain (A3)	1	$.55^{*}$	.36	.17	.29	.43	.59
The skill to analyze (A4)		1	$.50^{*}$	$.50^{*}$	.26	$.60^{**}$	.32
Problem-solving skill (A5)			1	$.76^{**}$	.25	$.80^{**}$	.30
The skill predict (A6)				1	.35	$.64^{**}$	.20
Enthusiasm, perseverance (A8)					1	.29	$.48^{*}$
Overcoming difficulties (A10)						1	.35
Understanding about the importance of STEM (A13)							1

* Correlation is significant at the .05 level (2-tailed).

** Correlation is significant at the .01 level (2-tailed).

The correlation analysis showed that respondents, who were aware of the importance of mathematics to solve problem tasks in science according to the level of requirements in Grade

9 (Skola2030, 2019a), saw a close relation between overcoming the difficulties (A10) and the acquired skills: the skill to solve problems (A5, $r_s = .80$), the skill to analyze (A4, $r_s = .60$), the skill to predict (A6, $r_s = .64$). There is also a close relation ($r_s = .48$) between the understanding about the importance of STEM and perseverance (A8), which is vitally necessary for every learner in the acquisition of science and mathematics.

Discussion

Learning by doing is characteristic in STEM acquisition. The use of practical real-life examples, inquiry and experimental teaching/learning methods, the project-based and problem-solution-based approach, modelling and visualization – such a many-sided approach - forms students' holistic understanding of STEM (Birzina et al., 2021a; Birzina et al., 2021b).

At the same time, it should be mentioned that pluralism of views describes the generation of the 21st century – different views about the importance of natural sciences, about whether STEM should be learnt only at school, or it should be related to everyday life. Not taking into consideration the diversity of students, differences in their thinking, opinions and learning styles, the shortcomings of the interdisciplinary teaching/learning process are confirmed. Certain tolerance towards young adults' personal views is needed in order to achieve that STEM learning becomes meaningful and personally significant for every student (Cedere et al., 2020).

Expressing the understanding about the importance of STEM knowledge in the national development, learning with interest is expected from Grade 9 students, mainly meaning their performance/action in lessons, but not in the free time from school. Almost half of prospective teachers did not consider that exploration in the leisure time is important, thus they did not see how big importance there was if the student, observing nature and processes in real life, was able to apply the knowledge acquired at school and had interest about it. Linking the teaching/learning content with real life by no means should be restricted to the frame of the lesson. Just on the contrary, the aim of STEM education is to develop every learner's skill, necessary for practical real life. STEM develops thinking, creativity, problem solving skills that are needed for the emergence of new researchers, explorers, inventors, specialists of the many technical spheres who would be able to solve the problems of today's world (Maass et al., 2019).

Comparing the data about prospective teachers' views with results of Latvian students in the OECD PISA study in 2018 (Geske et al., 2020), a similar feature can be observed. Students lack content and epistemic knowledge or skills to apply this knowledge for solving more difficult tasks, the prospective teachers, in turn, under-appreciate such knowledge. Probably, the views of many prospective pre-school teachers about what Grade 9 students must know and be able to do, have been influenced by not a sufficient analytical approach to separate the level of teaching/learning requirements according to the respective age group, i.e., pre-school and basic school.

Integration of science subjects largely is based on the research elements (Moore et al., 2015). Skills – to analyze, evaluate, and solve problems connected with practical life require complex knowledge from Grade 9 students, including also the skill to solve mathematical tasks (Andersone, 2020). Mathematics is not an easy subject for everyone, but a good teacher will find a way how to help the learner to succeed. Teacher's passivity cannot be supported in this aspect (*Respondent A: Mathematics should be left as it is because either you understand it or not).* Unfortunately, the data show that many other respondents could have similar thoughts about it because the indicator of cognitive interest of mathematics is the lowest (*M* = 2.26, *SD* = 0.87). Comparing the data with the previous Grade 9 students' survey (Cedere et al., 2018), it is possible to state that students' attitude to mathematics answering the same question is equally low (*M* = 2.25; *SD* = 1.15). Only 7% of the surveyed prospective pre-school teachers are convinced that in order to solve some problem tasks in biology, chemistry or physics in Grade 9, students need to have deep enough knowledge in mathematics.

Following the correlation analysis, those respondents who value highly the importance of mathematics skills are also certain that one can succeed in the STEM learning process only overcoming the difficulties. The correlation analysis proves that only a part of prospective teachers have a good understanding about the relation between STEM subjects as well as between the characteristic features of STEM learning – inquiry skills, perseverance and not being afraid of difficulties.

Integration of STEM subjects is a way how to make learning meaningful for students (Stohlmann et al., 2012; Takeuchi et al., 2020). Prospective pre-school teachers with more life experience have a more explicit understanding about deep learning of STEM subjects. They consider important the interest about the structure and functions of the human organism, the use of modified organisms in food production and medicine.

Learning with interest is especially important in STEM subjects, which seem difficult for many students, and therefore learning of these subjects requires certain effort (Jurgena et al., 2018; Osborne et al., 2003). High evaluation of cognitive interest and understanding about STEM teaching/learning methods is proven by respondents' answers to the open questions (*Respondents B: To my mind, the main way how to stir students' interest in science is to make the learning process more practical and exciting, showing students how actually common and valuable this knowledge can be. Let everyone who learns science have joy, inspiration, and many creative ideas)*

Comparing the data with the previous Grade 9 students' survey (Cedere et al., 2018), it is possible to see that prospective teachers feel more responsible as regards STEM learning, and they value much higher the cognitive interest.

The use of hands-on, practical, interest-stimulating methods that make the learning easier (Martínez-Borreguero et al., 2019), is also highly appreciated by respondents (*Respondents C: …so that children are not bored in lessons, but are truly interested, experiment, explore. One should learn and again learn to achieve something*).

The results of the study confirm the close connection between the teachers' methods of teaching and students' academic performance, emphasizing the principle of continuity in education which gives the prospective teachers a more comprehensive idea about the STEM education process in general.

The performed study has some limitations. This can be viewed as a pilot study therefore the obtained results should be treated as tentative. The study refers to exploring the views of first year students of the University of Latvia - prospective pre-school teachers, thus the results cannot be assessed and interpreted in a broader context.

Conclusions and Implications

Performing the study, it has been established that the prospective pre-school teachers considered cognitive interest and active, inquiry-based learning as especially important in STEM education. The importance of STEM knowledge for the national development has been highly assessed, and the respondents with more life experience have admitted it with greater certainty. The study allowed stating that the prospective pre-school teachers have a general idea about STEM learning in Grade 9 of the basic school; however, they have not assessed high enough the mathematical skills. It is essential that the prospective pre-school teachers have noticed the connection between STEM learning and such important character features as perseverance and not avoiding the difficulties.

The present study has given a possibility to understand better the prospective pre-school teachers' needs in order to improve the teacher education programs at the university. The prospective pre-school teachers need to have the idea about the STEM learning in the next stage of education to develop a better successive link between the pre-school and further schooling, thus making the children's learning easier. Continuing the study in the context of continuity in education, the authors envisage focusing more on the coordination of the teaching/learning content of separate stages of education.

Declaration of Interest

The authors declare no competing interest.

References

Andersone, R. (2020). Innovations in the improved curriculum content of the competence approach: A case study in Latvia. In V. Dislere (Ed.), *The Proceedings of the International Scientific Conference Rural Environment. Education. Personality (REEP)* (pp. 213-218). Latvia University of Life Sciences and Technologies https://doi.org/10.22616/REEP.2020.025

Babic, N. (2017). Continuity and discontinuity in education: Example of transition from pre-school to school. *Early Child Development and Care*, *187*(10), 1596-1609. https://doi.org/10.1080/03004430.2017.1301935

Barcelona, K. (2014). 21st century curriculum change initiative: A focus on STEM education as an integrated approach to teaching and learning. *American Journal of Educational Research*, *2*(10), 862-875.

Beļickis, I., Blūma, D., Koķe, T., Markus, D., Skujiņa, V., & Šalme, A. (2000). *Pedagoģijas terminu skaidrojošā vārdnīca* [Dictionary of pedagogical terms]. Apgāds Zvaigzne ABC.

Binkley, M., Erstad, O., Herman, J., Raizen, S., Ripley, M., Miller-Ricci, M., & Rumble, M. (2012). Defining twenty-first century skills. In P. Griffin, B. McGaw, E. Care (Eds.), *Assessment and teaching of 21st century skills* (pp. 17-66). Springer.

Birzina, R., Pigozne, T., & Cedere, D. (2021a). Students' readiness for STEM learning within the context of national education reform. In L. Daniela (Ed.), *Human, Technologies and Quality of Education* (pp. 657–752). LU Akadēmiskais apgāds.

Birzina, R., Pigozne, T., & Lapina, S. (2021b). Trends in STEM teaching and learning within the context of national education reform. In V. Dislere (Ed.), *The Proceedings of the International Scientific Conference Rural Environment. Education. Personality (REEP)* (pp. 41-49). Latvia University of Life Sciences and Technologies. https://doi.org/10.22616/REEP.2021.14.004

Brenneman, K. (2011). Assessment for pre-school science learning and learning environments. *Early Childhood Research & Practice*, *13*(1), 1-9. https://files.eric.ed.gov/fulltext/EJ931225.pdf

Carr, W., & Kemmis, S. (2003). *Becoming critical: Education, knowledge and action research*. Routledge.

Cedere, D., Birzina, R., Pigozne, T., & Vasilevskaya, E. (2020). Perceptions of today's young generation about meaningful learning of STEM. *Problems of Education in the 21st Century*, *78*(6), 920-932. https://doi.org/10.33225/pec/20.78.920

Cedere, D., Jurgena, I., & Targamadze, V. (2018). Interest of Latvian and Lithuanian students in science and mathematics. *Journal of Baltic Science Education*, *17*(1), 31-42. https://doi.org/10.33225/jbse/18.17.31

Çiftçi, A., Topçu, M. S., & Foulk, J. A. (2020). Pre-service early childhood teachers' views on STEM education and their STEM teaching practices. *Research in Science & Technological Education*. https://doi.org/10.1080/02635143.2020.1784125

Dass, P. (2015). Teaching STEM effectively with the learning cycle approach. *K-12 STEM Education*, *1*(1), 5-12. https://doi.org/10.33225/pec/21.79.728

Davydov, V. V., & Kudriavtsev, V. T. (1998). Development education. *Russian Education and Society, 40*(7), 37-64. https://doi.org/10.2753/RES1060-9393400737

Dewey, J. (1986). Experience and education. *The Educational Forum, 50*(3), 241-252. https://doi.org/10.1080/00131728609335764

Dewey, J. (1997). *Democracy and education: An introduction to the philosophy of education.* The Project Gutenberg. https://www.gutenberg.org/ebooks/852

Fiksl, M., Flogie, A., & Aberšek, B. (2017). Innovative teaching/learning methods to improve science, technology and engineering classroom climate and interest. *Journal of Baltic Science Education, 16*(6), 1009-1019. https://doi.org/10.33225/jbse/17.16.1009

Eurydice Report. (2019). *Key data on early childhood education and care in Europe*. Publications Office of the European Union. https://eacea.ec.europa.eu/national-policies/eurydice/sites/default/files/ec0319375enn_0.pdf.

Gajić, M. M., Županec, V. D, Babić-Kekez, S. S., & Trbojević, A. R. (2021). Methodological approaches to the study of inquiry-based learning in natural science education. *Problems of Education in the 21st Century, 79*(5), 728-750. https://doi.org/10.33225/jbse/21.20.184

Geske, A., Grīnfelds, A., Kangro, A., Kiseļova, R., & Stūre, B. (2020). Latvijas skolēnu sasniegumi un skolas vide OECD PISA salīdzinājumā [Latvian students' performance and school environment in OECD PISA comparison] In A. Kangro (Ed.) *Educational Research in Latvia*, Monograph 11. University of Latvia, Faculty of Pedagogy, Psychology and Art, Educational Research Institute. https://www.ipi.lu.lv/fileadmin/user_upload/lu_portal/projekti/ipi/PISA/PISA2015_sekundarie_petijumi.pdf

Hom, E. J. (2014). *What is STEM education?* https://www.livescience.com/43296- what-is-stem-education.html

Howitt, C., Lewis, S., & Upson, E. (2011). ‘It's a mystery’: A case study of implementing forensic science in pre-school as scientific inquiry. *Australasian Journal of Early Childhood*, *36*(3), 45-55. https://doi.org/10.1177/183693911103600307

Jurgena I., Cedere D., & Keviša, I. (2018). The Prospects of transdisciplinary approach to promote learners’ cognitive interest in natural science for sustainable development. *Journal of Teacher Education for Sustainability, 20*(1), 5-19. https://doi.org/10.2478/jtes-2018-0001

Kelley, T. R., & Knowles, J. G. (2016). A conceptual framework for integrated STEM education. *International Journal of STEM Education*, *3*(1), 1-11. https://doi.org/10.1186/s40594-016-0046-z

Maass, K., Geiger, V., Ariza, M. R., & Goos, M. (2019). The role of mathematics in interdisciplinary STEM education. *ZDM*, *51*(6), 869-884. https://doi.org/10.1007/s11858-019-01100-5

Martínez-Borreguero, G., Mateos-Núñez, M., & Naranjo-Correa, F. L. (2019). Implementation and didactic validation of STEM experiences in primary education: Analysis of the cognitive and affective dimension. In *Theorizing STEM Education in the 21st Century*. IntechOpen. http://dx.doi.org/10.5772/intechopen.88048

McCall, J. (2017). Continuity and change in teacher education in Scotland-back to the future. *European Journal of Teacher Education, 40*(5), 601-615. https://doi.org/10.1080/02619768.2017.1385059

Moore, T. J., Johnson, C. C., Peters-Burton, E. E., & Guzey, S. S. (2015). The need for a STEM roadmap. In C. C. Johnson, E. E. Peters-Burton, & T. J. Moore (Eds.), S*TEM road map: A framework for integrated STEM education* (pp. 3-12). Routledge.

NAP. (2020). *Nacionālais attīstības plāns 2021. – 2027. gadam* [National development plan for 2021-2027]. https://www.pkc.gov.lv/sites/default/files/inline-files/20200204_NAP_2021_2027_gala_redakcija_projekts_.pdf

National Reforms in School Education. (2020). https://eacea.ec.europa.eu/national-policies/eurydice/content/national-reforms-school-education-34_en

Osborne, J., & Hennessy, S. (2003). *Literature review in science education and the role of ICT: Promise, problems and future directions*. Futurelab. https://telearn.archives-ouvertes.fr/hal-00190441

Osborne, J., Simon, S., & Collins, S. (2003). Attitudes towards science: A review of the literature and its implications. *International Journal of Science Education, 25*(9), 1049-1079. https://doi.org/10.1080/0950069032000032199

Skola2030. (2019a) *Dabaszinātnes* [Science]. https://www.skola2030.lv/lv/macibu-saturs/macibu-jomas/dabaszinatnes

Skola2030. (2019b) *Pirmsskola* [Pre-school]. https://www.skola2030.lv/lv/istenosana/izglitibas-pakapes/pirmsskola

Skola2030. (2019c). *Pirmsskolas mācību programma* [Pre-school curriculum]. https://mape.skola2030.lv/resources/10

Stohlmann, M., Moore, T. J., & Roehrig, G. H. (2012). Considerations for teaching integrated STEM education. *Journal of Pre-College Engineering Education Research, 2*, 28-34. https://doi.org/10.5703/1288284314653

Surma, B., Rosati N., Menon, S., Fuertes, M. T., Farren, M., & Maguire, F. (2019). Kitchen lab for kids: A programme for shaping STEM skills in pre-school. *Edukacja Elementarna w Teorii i Praktyce, 14*(4), 61-70. https://doi.org/10.35765/eetp.2019.1454.05

Takeuchi, M. A., Sengupta, P., Shanahan, M-C., Adams, J. D., & Hachem, M. (2020). Transdisciplinarity in STEM education: A critical review. *Studies in Science Education*, *56*(2), 213-253. https://doi.org/10.1080/03057267.2020.1755802

Tsupros, N., Kohler, R., & Hallinen, J. (2009). *STEM education: A project to identify the missing components.* Leonard Gelfand Center for Service Learning and Outreach at Carnegie Mellon University, and The Intermediate Unit 1 Center for STEM Education. https://www.cmu.edu/gelfand/documents/stem-survey-report-cmu-iu1.pdf

Tytler R. (2020). STEM education for the twenty-first century. In J. Anderson & Y. Li (Eds.), *Integrated Approaches to STEM Education. Advances in STEM Education* (pp. 21-43). Springer. https://doi.org/10.1007/978-3-030-52229-2_3

Received: *January 02, 2022* Accepted: *February 12, 2022*

Cite as: Cedere, D., Jurgena, I., Birzina, R., & Kalnina, S. (2022). Prospective pre-school teachers' views on STEM learning in grade 9: The principle of continuity in education. *Problems of Education in the 21st Century*, *80*(1), 69-81. https://doi.org/10.33225/pec/22.80.69

Dagnija Cedere *(Corresponding author)*	Dr.chem., Associate Professor, University of Latvia, Jelgavas iela 1, Riga LV-1004, Latvia. E-mail: dagnija.cedere@lu.lv ORCID: https://orcid.org/0000-0002-6654-3054
Inese Jurgena	Dr.paed., Professor, University of Latvia, Imantas 7.līnija, Riga LV-1083, Latvia. E-mail: inese.jurgena@lu.lv ORCID: https://orcid.org/0000-0002-1862-110X
Rita Birzina	Dr.paed, Leading Researcher, University of Latvia, Jelgavas iela 1, Riga, LV-1004, Latvia E-mail: rita.birzina@lu.lv ORCID: https://orcid.org/0000-0002-6124-1073
Sandra Kalnina	Mg.paed., Mg.phil., Lecturer, University of Latvia, Imantas 7.līnija, Riga LV-1083, Latvia. E-mail: sandra.kalnina@lu.lv

This is an open access article under the
**Creative Commons Attribution 4.0
International License**

PROBLEMS
OF EDUCATION
IN THE 21st CENTURY
Vol. 80, No. 1, 2022

PERCEPTIONS AND RECOMMENDATIONS OF FOREIGN LANGUAGE TEACHERS TO PREVENT CHILDREN VIOLENCE AND ABUSE: A CASE STUDY IN TISHK INTERNATIONAL UNIVERSITY STUDENTS IN ERBIL, IRAQ

Bunyamin Celik, Yunus Yildiz, Recep Bilgin
Tishk International University, Iraq
E-mail: bunyamin.celik@tiu.edu.iq, yunus.yildiz@tiu.edu.iq,
recep.bilgin@tiu.edu.iq

Abstract

Violence and abuse against children are important social issues for teachers. The aim of this study was to determine the perceptions of foreign language students, regarding violence and abuse against children, and their suggestions for preventing violence. The research was designed in the case study pattern, which is a qualitative research method. The study group of the research consists of 82 first year and second year foreign language pre-service teachers studying at Tishk International University, Faculty of Education, and voluntarily agreeing to participate in the research. The data of the study were obtained by using the structured "Recommendations Form for Preventing Violence and Abuse Against Children" developed by the researchers. Written data were analyzed by content analysis method. 82 students from first and second years at Education Faculty were interviewed and their opinions were taken. There were some subheadings during the survey: family, laws, national and international non-governmental organizations, schools and teachers, society, media, and art. They expressed their opinions about what the functions of these organs should be to prevent the violence and abuse against children. The pre-service teachers attached important duties to each of these organs separately. It is concluded that the prevention of violence and abuse against children can only be achieved in cooperation and separate duties of these organs. It is also recommended that courses and training that will provide pre-service teachers with knowledge, skills and awareness about violence and abuse against children should be placed in the curriculum as compulsory in education faculties.

Keywords: *violence and abuse against child, prevention of abuse, foreign language pre-service teacher*

Introduction

The World Health Organization defines violence as "the intentional use of physical force or power, threatened or actual, against oneself, against another person or against a group or community, which either results in or has a high likelihood of resulting in injury, death, psychological harm, mal-development, or deprivation" (World Health Organization, 2011). Lawyers state that acts of violence are "acts of aggression and rudeness that people commit against others, causing significant or insignificant damage or injury to them". This definition emphasizes the link between violence and the use of force that causes permanent bodily harm (Polat, 2014). According to Krug et al., violence, which is generally defined as the behavior of mentally or physically harming oneself or another, has existed from the past to the present

https://doi.org/10.33225/pec/22.80.82

(Krug et al., 2002). In addition, in the developing world, especially in recent years, with the increasing emphasis on human rights at the global level, the importance of studies to prevent violent behavior has increased (Hahn et al., 2007). In this context, countries, especially many international official institutions and foundations, carry out studies to prevent violence and abuse through the policies they maintain and the training programs they develop in this direction.

The groups that experience violence and abuse the most are children, women, and the elderly. It is reported that millions of children around the world suffer or witness physical, sexual, or emotional violence every year. In every culture, every age in the history of humanity, children have been exposed to violence in various forms. The examples of violence in history can be given to the practices of accepting children as paternal property, selling them as slaves, presenting them as offerings, leaving the newborns in a cold river to see if they are healthy and legitimate, offering the girls to the guests who come to the house and similar practices (Unicef, 2009). In today's world, although everyone accepts the protection of children, who will shape the social structure of the future, many children who are still unprotected, powerless and unable to defend their rights are still exposed to violence. Every child has the right to live a healthy life free from violence. In Article 19 of the “United Nations Convention on the Rights of the Child”, for the contracting states to protect the child against physical or mental assault, violence or abuse, neglect or negligent treatment, abuse and ill-treatment including rape, they are asked to take all legal, administrative, social and educational measures (Bennett et al., 2009).

Childhood is the most special and sensitive period in which the foundations of a person's future life are laid. During this period, while developmental, cognitive, and behavioral changes occur rapidly in the child, the negativities experienced by the child do not only negatively affect his health for that process, but also prevent the child's healthy growth and development. The cases of violence against children are the ones that cause the greatest harm among the cases of violence, which are mostly not revealed. In addition, cases of violence against children are also called child abuse in general because they prevent the development of the child (Corby, 2005). Child abuse is defined as “the exposure of children of all age groups who are not legally adults to a harmful, non-accidental and preventable behavior by the person or persons responsible for their care” (Howe, 2007).

Research Problem

This study was done in a country which went through agonizing experiences and wars in the last thirty years. The last devastating attack took place in the country by ISIS forces and the country was deeply affected by these attacks financially and socially. The country started to go through a new post-conflict construction phase. During this period, the government is trying hard to provide security, and the public is reshaping their culture and social relations. This study was done on the pre-service teachers who are the part of this reconstructing society. The opinions of the university students in a transition era were reflected in this study.

Types of Violence and Abuse against Children

In general, violence and abuse against children is defined as follows according to many international organizations and as a result of research conducted in the field: They are the harming behaviors carried out against individuals between the ages of 0-18 who have not yet completed their mental and physical development and are more sensitive than adults, and they negatively affect the physical, psychological and social development of the child (Hillis et al., 2017; Gil, 2013; Jones et al., 2012; World Health Organization 2002). Violence against children is often perpetrated by adults, especially their parents, who are responsible for caring for or educating them. A reflection of this is realized by neglect. Neglect is the failure of the person or persons responsible for taking care of the child to fulfill this obligation, neglecting the child physically or emotionally. It is defined as not showing the necessary attention for nutrition, clothing, medical needs, emotional needs, or optimal living conditions. Neglect should be considered in children with growth retardation, psychosocial adjustment difficulties, whose educational needs are not met, and who do not benefit from preventive health services. Normally abuse and violence against children are examined in four groups, primarily physical and emotional (psychological), economic and sexual, but after technology and cyber violence entered our homes through information and telecommunication tools, they are not examined in five groups anymore (Al-Nasrawi, 2021; Hillis et al., 2016; Jones et al., 2012; Kardefelt-Winther & Maternowska, 2020).

Physical Violence/Abuse: Physical abuse can be defined in the broadest sense as “non-accidental injury of the child”. It is the use of physical force against a child in a way that harms their health, development, or dignity. It includes actions such as hitting, kicking, burning, biting, shaking, scalding, poisoning, trying to strangle. In many studies, physical violence or abuse is defined as a situation of violence that results in the risk of injury to the child as a result of physical abuse (Hillis et al., 2016; Tourigny et al., 2008).

Emotional (Psychological) Violence/Abuse: Emotional or, in other words, psychological violence is the situation in which children and young people suffer psychological damage in accordance with social and scientific standards by being exposed to attitudes and behaviors that negatively affect them, or by depriving them of the attention, love and care they need (McCoy et al., 2020). These behaviors are implemented by the person or persons who have an influence on the child or young person with their prior status such as age, social status, knowledge, and position (Thoresen et al., 2015).

According to the research, the main emotional violence behaviors faced by children are constantly criticizing, humiliating, belittling, shouting, ignoring when the child asks for help, refusing to help, shouting at them in front of others, embarrassing them, calling them derogatory nicknames, giving heavy work/responsibilities that are not appropriate for their age, excessive pressure, and authority to engage them in criminal activities (Holt et al., 2008; Howe, 2007). When children are exposed to this type of emotional violence, they feel unloved, worthless, and their self-confidence is harmed. In addition, children who have been exposed to emotional abuse have difficulties in establishing healthy relationships with their peers or adults. The child who has been subjected to violence may be exposed to different types of violence at the same time. Emotional abuse often accompanies physical abuse and sexual abuse (Seddighi et al., 2021).

Economic Violence/Abuse: It is the desire of the person or persons responsible for the child to see the child as a source of financial income and to gain financial gain from the child. As a result of seeing the child as a source of financial gain, making him work, begging or leaving him in need of money are the main examples of economic violence (World Health Organization., 2019; Pereznieto et al., 2014). Parents can use their children to satisfy their urge to earn a lot of money. In another definition, economic violence is defined as working in jobs that prevent the development of the child, violate their rights, or being used as a low-paid laborer (Spring, & Bahar, 2009).

The reasons why children are exposed to economic violence and abuse are closely related to their social, economic, and cultural problems in the society they belong to. As a result of the increasing injustice in the income distribution in the world, widespread poverty, rapid migration from the village to the city and the resulting social and economic problems, the increase in illegal labor, the cheapness of child labor and the employer's preference for cheap labor, the problem of children working or forced into working life arises (World Health Organization, 2011). Children are deprived of these rights at the age when they will live their childhood and receive education. They may experience health problems due to economic abuse and working in unhealthy conditions. Children's work at a young age, for a long time and in workplaces with unsuitable working conditions can adversely affect their development (Adams et al., 2008).

Sexual Violence/Abuse: Sexual abuse is the use of a boy or girl who has not completed their psychosocial development and is underage, by an adult for sexual purposes. It is the use of a child, by an adult, or one that is developmentally older person, for sexual gratification. This includes many behaviors such as touching the genitals, wanting the child to touch their own sexual organs, penetration into the vagina or anus of the child, taking nude photos of the child, using these photos on the internet, exposing the child to the adult's naked body (exhibitionism) (Deb & Modak, 2010; Kitzinger, 2004). While sexual abuse that can be directed against a child within the family is defined as incest, those perpetrated by unknown persons are defined as pedophilia.

Childhood sexual violence causes significant mental, cognitive, and social problems in children. In order to help a child who has been subjected to child violence, first of all, it is necessary to recognize the signs and symptoms that abuse can create on the child, to know what behavioral characteristics these children may have, and which behaviors are indicators of abuse. In addition, the fact that children who are victims of sexual abuse are not supported by their families and circles and that an appropriate approach to the child is not adopted, causes the psychological problems of children to worsen (Ozturk et al., 2009).

Cyber Violence/Bullying: With the increase in the use of information technologies, many problems have emerged. Technological developments and ease of access cause young people and children to spend most of their time on the Internet. Especially children and young people are the group most affected by these developments. As a matter of fact, with the widespread use of the internet and mobile phones, children now communicate easily and uncontrollably on all kinds of virtual platforms. Violence and bullying have been transferred to these environments in different ways with the communication established in virtual environments. The situation where children are exposed to violence through information and communication technologies in all online digital platforms is defined as cyber violence or cyber bullying (Kardefelt-Winther & Maternowska, 2020; Nagle et al., 2017).

This new type of violence against children emerges as a new problem in families and schools. With mobile phones and tablet computers, it has now become possible to do 'non-stop bullying' anywhere and anytime. Cyberbullying is worse than verbal and physical bullying. Because children usually do not tell anyone about what has been done, no one knows what is going on. The bully does not feel guilty for not seeing the other child's face. Since there is no face-to-face meeting in cyberbullying, it is also easy to hide. While the majority of children do not see such events as a problem, some of them complain about this situation (Al-Nasrawi, 2021).

Cyberbullying and traditional bullying are similar in some ways. Studies have shown that there are significant relationships between traditional bullying and cyberbullying in terms of both being a victim and a bully. It has been determined that many of the children who participate in peer bullying also engage in cyberbullying. In peer bullying, the strong bully the weak, while in cyber bullying, the situation can be the opposite. Psychological, social, and academic problems occur in children who are exposed to cyberbullying. Behavioral disorders such as aggression and breaking the rules are frequently encountered in children who engage in cyberbullying (Jones et al., 2012).

Although these violence groups are seen separate, in some cases more than one type of violence can occur at the same time. Unfortunately, although these cases of violence against children differ from each other, they all negatively affect the physical, psychological, and social health of children and may cause children to become violent people themselves (Waterston & Mok, 2018). It is known that children's exposure to or witnessing violence negatively affects their development. As a matter of fact, finding similar characters as friends and developing their potential in this way among the peers causes them to encounter more difficult and complex situations.

According to many international reports and academic studies prepared in this area, children may experience important problems such as decreased communication with peers and parents, sleep disorders, anti-social behaviors, academic problems, loss of self-confidence, fear reactions, depression, and suicide as a result of exposure to violence (Gil, 2013; Hillis, et al., 2017; Jones et al., 2012; Krug et al., 2002; World Health Organization, 2019;). These studies and the reports published periodically by international institutions show that violence against children negatively affects both the present and future life of the child. In this context, it is clearly understood that the studies to be carried out to prevent violence against children have an important place in terms of children's mental health (Cookson, 2021; Rubenstein & Stark, 2017).

Preventing Violence and Abuse against Children and the Role of the Teacher

The causes of violence and its effects on children are multidimensional. For this reason, studies on preventing violence and abuse against children are possible with the collaboration of different disciplines. In this context, interdisciplinary studies in which health professionals, lawyers, teachers, social workers, psychologists, psychological counselors, and bureaucrats work together are needed (McCoy et al., 2020; Hillis et al., 2016). In this study, the opinions and suggestions of the foreign language pre-service teachers who will work in educational institutions are the focus of the research. Because when children are first introduced to school, it becomes a place where they spend a significant part of their lives (Wilson et al., 2011). An important part of children's development takes place in the school environment. Besides teaching, another major role of teachers is to take an important role in shaping children's lives, revealing their problems and solving them (Davis, 2003; Pianta, et al., 2003; Roorda et al., 2011). Moreover, teachers play an active role in recognizing the violence and abuse situations experienced by children and initiating the necessary intervention services. At the same time, studies can be carried out to prevent violence in schools (McCoy et al., 2020; Hillis et al., 2006).

There are also research results revealing that pre-service teachers have a high level of sensitivity to violence against children (Devries et al., 2013). As a matter of fact, as the pre-service teachers' sensitivity towards violent behaviors increases, their rate of reaction to violence may increase (Becker, 2017; Smith et al., 2006). Therefore, it is obvious that the suggestions of pre-service teachers with high levels of sensitivity towards violence against children will guide practitioners, families, program development experts and lawmakers. In addition to this information, as observed in many international academic studies, it has been determined that foreign language pre-service teachers create different areas of influence on children sociologically and culturally than pre-service teachers in other branches (Borg, 2006; Byram, 1989; Risager, 2007; Sercu, 2005; Thanasoulas, 2001;). The reason for this is that during the foreign language learning process, besides learning a new language, children also have to learn a different culture, mindset and environment from those they live in (Bayyurt, 2006; Celik & Yildiz, 2019; Kramsch, 2013; Kramsch & Thorne, 2002). Therefore, the research presents the opinions and suggestions of the volunteer foreign language pre-service teachers on the subject.

The aim of this study was to determine the perceptions of foreign language pre-service teachers, who have the opportunity to bring a different culture and understanding to the classroom environment, on preventing violence and abuse against children. There is a bulk of professional studies on the subject abuse and violence against children, but the pre-service teachers may have to deal with that problem practically, so their perceptions and suggestions are important to determine how knowledgeable they are about this issue.

In line with this purpose, in the research, the answer to this problem statement was sought. The following research questions arose for the study:

1. What are the perceptions and suggestions of foreign language pre-service teachers about preventing violence and abuse against children?
2. What are the perceptions and suggestions of foreign language pre-service teachers about preventing violence and abuse against children?
3. What do they think about the function of the family to prevent violence and abuse?
4. What do they think about the function of the laws to prevent violence and abuse?
5. What do they think about the function of the National and International Non-Governmental Organizations to prevent violence and abuse?
6. What do they think about the function of the school and teachers to prevent violence and abuse?
7. What do they think about the function of the society to prevent violence and abuse?
8. What do they think about the function of the media organs to prevent violence and abuse?
9. What do they think about the function of the art and the cinema to prevent violence and abuse?

As a matter of fact, violence emerges as a social phenomenon that has been realized in different ways from past to present. In today's world where telecommunication tools are developing rapidly, unfortunately, the spread of news of violence and abuse against children clearly reveals the importance of preventive and protective studies on this issue. In this context, it is anticipated that examining the approaches and suggestions of foreign language pre-service teachers, who are expected to work with children in their professional life, observe them, evaluate them in different ways and conditions, provide necessary guidance and have many social experiences with them, on preventing violence and abuse against children will contribute to the prevention methods to be carried out. Based on this idea, the recommendations of pre-service foreign language teachers on preventing violence and abuse against children were examined in the study.

Research Methodology

Research Model

The model of the research is in the form of scanning model, and it was designed in semi-structured interview. This case study pattern aims to understand situations in a specific context (Thomas, 2021). In this design, real-life events are handled holistically and closely examined in detail (Thomas, 2021; Hennink et al., 2020). The case study design consists of three basic steps: defining the situation, determining the appropriate type for the design, and using the theory (Yazan, 2015). In this study, violence and abuse against children was determined as a situation. It is designed to examine this situation holistically with a single-case design. The findings were discussed theoretically within the framework of the literature on ways to prevent violence and abuse against children.

Working Group

The study group of the research consisted of 82 first-and-second-year foreign language students who study at Tishk International University Faculty of Education and agreed to participate voluntarily in the research. Criterion sampling, one of the purposive sampling methods, was used to determine the study group (Hennink et al., 2020). In the criterion sampling method, the criteria that are thought to be important for the research were determined and the

https://doi.org/10.33225/pec/22.80.82

study group was formed. As a criterion for the determination of the working group, it was requested that the pre-service teachers be equipped with certain skills regarding the teaching profession and have a positive perspective towards their profession. It was thought that they could reach a certain level of awareness about violence and abuse against children only under this condition. The characteristics of the foreign language pre-service teachers participating in the research are shown in Table 1.

Table 1
Demographic Information on Pre-service Teachers Participating in the Research

Variable	Category	*n*	%
Gender	Female participant	58	71
	Male participant	24	29
Department	English Language Teaching	62	76
	Turkish Language Teaching	20	24
Grade	First Year	38	46
	Second Year	44	54
Status of Attending Educational Seminars on Children	Participating	56	68
	Non-participating	26	32
Attendance at a National or International Academic Conference on children	Participating	14	17
	Non-participating	68	83

In Table 1, demographic information of the pre-service teachers participating in the research is given in five different variables. 24 (29%) of the foreign language pre-service teachers participating in the research are male and 58 (71%) females. 62 of the pre-service teachers (76%) are studying English language teaching, and 20 (24%) are studying Turkish language teaching. In addition, 38 (46%) of the pre-service teachers participating in the research are junior grade students and 44 (54%) are senior grade students. In addition, while 56 of the pre-service teachers (68%) attended any training seminars related to children, 26 of the pre-service teachers (32%) did not attend any training seminars related to children. Finally, 14 (17%) of the pre-service teachers participating in the research attended a national or international academic conference on children, while 68 (83%) did not.

Instrument and Procedure

All the data for the study were obtained from the participants in writing. During data collection, all necessary explanations were given to the participants and a two-hour seminar was organized within the university and information was given about the subject and importance of the research. Data collection time varied between 20 and 25 minutes. All participants in the study were involved in the process voluntarily.

The data of the study were obtained by using the structured "Recommendations Form for Preventing Violence and Abuse Against Children" developed by the researchers. This form consists of two parts. In the first part, there is a personal information form that includes questions to determine the characteristics of pre-service teachers. In the second part of this form, the pre-service teachers were asked, "What do you think should be done to prevent all kinds of violence and abuse against children?". By asking the question, their perceptions, and suggestions about preventing violence and abuse against children were determined. While developing the data collection tool, the literature on types of violence and abuse against children was reviewed. The semi-structured interviews were also held with pre-service teachers regarding their sensitivity to violence and abuse against children, and after these interviews, a data collection tool for preventing violence/abuse was created. In order to ensure the content validity of the draft form, the forms and academic contents created in the field article were reviewed, and then expert opinions were obtained from three academicians working in the field of guidance and psychological counseling. The form was finalized in line with the feedback from the experts.

Data Analysis

The obtained written documents were analyzed by qualitative content analysis method. Research data were categorized through specific themes, sub-themes, and codes. It is planned to reach a meaningful conclusion through this coding and categorization (Gibbs, 2007). The names and ranks of the foreign language pre-service teachers participating in the research were shortened and coded as "FLTC1... FLTC1" (Foreign Language pre-service teachers). At least some of the ideas and suggestions of all students were coded and presented.

Their ideas were classified into groups in which they are in accordance, and the approaches in different subtopics were brought together to see the results in general. In one subtopic, the pre-service teachers explained their ideas, and we brought them together and coded accordingly. The points that look similar were analyzed under the same heading. The differences were also noted down and expressed in the study. In the end, differing ideas were evaluated together.

The suggestions of the foreign language pre-service teachers on preventing violence and abuse against children are grouped and specified under seven sub-themes as “family, laws, national and international non-governmental organizations, society, school-teacher, media and art”.

Validity and Reliability of the Research

In order to ensure validity in the research, the context and the situation with which the data are related were taken into account and the findings were interpreted accordingly. In addition, in the method section, the research model, study group, data collection tools, data collection and analysis processes are reported in detail with all steps (Gelissen, 2010; Hennink et al., 2020; Patton, 2014).

In order to increase the reliability, the coding that the researchers made individually during the analysis of the data were compared by coming together and a consensus was reached by making changes on the codes. Clearly defining and expressing the roles of researchers in the research is another measure taken to increase reliability (Bazeley, 2021). In this research, the researchers also took an active role in all processes of the research as the implementers of the data collection tools. They explained the subject and purpose of the research to the participants in all details. In addition, with the aim of increasing the perceptions of the participants about the subject and improving their own knowledge, all students participating in the study were given a two-hour seminar on “Violence/abuse to children” by researchers, under the supervision and guidance of four academicians working in the field of guidance and psychological counseling.

Research Results

Starting from Table 3, the frequencies of the responses related to these sub-themes were included in Tables 4,5,6,7,8 and 9 along with the perceptions and suggestions of all foreign language pre-service teachers participating in the research. The frequency in the tables refer to how many percent of the students mentioned these topics during the interviews.

Table 2
Frequencies of Sub-Themes in Preventing Violence and Abuse against Children

Main Theme	Sub-themes	*f*
Preventing Violence Against Children	Family	71
	Laws	67
	National and international non-governmental organizations	60
	School - Teacher	54
	Society	41
	Media	36
	Art	16

When Table 2 is examined, it is seen that foreign language pre-service teachers mostly give place to opinions in the context of "family, official laws, national and international non-governmental organizations, society, school-teacher, media and art" in order to prevent violence and abuse against children.

Themes, sub-themes, and suggestion codes regarding the suggestions of the foreign language pre-service teachers to the families in preventing violence and abuse against children are given in Table 3.

Table 3
Recommendations for the Family in Preventing Violence and Abuse against Children

Theme	Sub-theme		Recommendation codes	*f*
Preventing Violence Against Children	Family	Code 1	Getting education that raises awareness before and after marriage	23
		Code 2	Valuing the children and having correct communication within the family	18
		Code 3	Improvement of socioeconomic conditions	15
		Code 4	Linking the family with a national or international organization	13
		Code 5	Raising children as good people	9
		Code 6	Teaching a child to resist violence	4

When Table 3 is examined, six recommendation codes were determined in the suggestions of the foreign language pre-service teachers regarding the family in preventing violence and abuse against the children.

Code 1: Getting awareness training before and after marriage:

In order to prevent violence against children, the pre-service teachers suggested organizing trainings to increase the awareness, knowledge and skills of families, who are the core of society, both before and after marriage. They emphasized that these trainings should be scientific and informative in the form of seminars or conferences.

Perceptions of pre-service teachers about Code 1:

FLTC13: "I think the most effective solution in this regard is pre-marital education. I am of the opinion that before marriage, spouses should attend the parent training program given by the state and marry with the certificate they received from this program." He suggested that families should receive education by being included in a program before marriage, and even stated that it should be enacted as a prerequisite for getting married. Thus, it aims to ensure that every parent-to-be goes through an appropriate education.

FLTC20: "The smallest building block of society is the family. A society that does not educate its parents can do nothing for the children of the future generation. In other words, violence against children can never be reduced without the education of parents or caregivers. Therefore, the child is also prone to violence in parallel with this. More seminars and conferences should be organized." In his words, he metaphorized children as the illuminators of the future and expressed family education as the basic condition for reducing violence against children.

FLTC71: "More education should be given to families. Violence mostly starts from the family. Precautions should be taken to prevent this situation. These measures should start with the education of families." In his words, he emphasizes that violence starts in the family and therefore attaches importance to the education of the family on this issue.

FLTC72: "Regular seminars can be given to families on this subject. Information can be given about what kind of actions can be counted as violence in the society." He suggests informing families about which behaviors are violence.

FLTC34: "I think that education can be more beneficial in this regard. I think that trainings such as how to react to the mistakes and wrong behaviors of their children and how to communicate with their children when they experience negative situations can be beneficial." As seen in his statement, he thinks that knowing healthy behavior control methods that families can use instead of using violence will reduce violence against children. In this context, it proposes the regulation of educational content.

Code 2: Valuing the children and correct communication within the family:

Pre-service teachers stated that in order to reduce violence against children, families should first accept that children are individuals and respect their personalities and existence. Thus, they emphasized that the first step of a healthy communication can be taken. Afterwards, they suggest that they communicate effectively with their children. They state that it is possible to provide this communication by organizing family-child activities. They think that this effective communication process between the family and the child can eliminate violence.

Perceptions of pre-service teachers about Code 2:

FLTC74: "I think communication within the family is a very important issue and is a tool in preventing violence. Regardless of their age, the children are ultimately individuals. As being human beings, they are individuals who have different spheres of influence on themselves and their environment. Within the family, parents must absolutely respect and consider the assets of their children. I believe that only healthy relationships can be established in this way."

FLTC62: "I believe it is very important for families to be conscious about communication among themselves. For this, trainings should be organized... Also, I think that children should be listened to and given importance because they are very valuable, and they are the future of this country." In his words, he emphasizes the importance of families listening to their children.

FLTC55: "Parents and teachers should be informed about this sensitive issue by attending conferences such as how to raise a child and how to communicate with a child." Not all adults who do not know how to talk to their children can prevent violence and its forms." He mentions the importance of communication in this process.

FLTC14: "I think families or caregivers should know more about children because we cannot ensure correct communication with people about whom we do not have enough information. Especially when our addressees are children, I think that families or their dependents should seek professional help to establish the right communication about children.

Code 3: Improvement of socioeconomic conditions:

It is seen that pre-service teachers think that improving the social and economic conditions of families is a factor that can reduce violence against children. They suggest that families should be ensured to reach high cultural, social, and economic levels. It may be difficult to achieve this aim, but they share the opinion that it is not impossible. They stated that a correct organization and help from governments, non-governmental organizations and charitable people are needed in this regard.

Perceptions of pre-service teachers about Code 3:

FLTC66: "I believe that a more prosperous level of families socially and economically is a major factor preventing violence and abuse against children. The governments that rule the country should help families financially and morally, especially in education. Free education, health and similar basic needs should be planned and organized by the state or non-governmental organizations."

FLTC53: "I think that the economic level and cultural development of the family have an impact on violence. Having enough money for the family to meet their needs and receiving the necessary basic education can eliminate violence against children. It is important to make arrangements in this regard."

FLTC68: "I think that if the socioeconomic levels of the parents are high, the violence against the children will decrease to the lowest levels. But unfortunately, there are not many families of this level around us. In this case, the state should directly assist families. I would also like to state that the wealthy businessmen in our society should help both the state and these families. Only with this kind of cooperation will the socioeconomic status of families improve."

FLTC30: "I think that the increase in cultural and socioeconomic wealth will prevent violence in the family. Parents who have received the right education will be more sensitive to all kinds of violence against children. Having a high level of financial means will have a significant impact on meeting the needs of the child. However, not every child can have the same opportunities. In this case, the state should have a policy and help families. At the same time, I think that rich people should help families in meeting their children's education and basic needs."

Code 4: Linking the family to a national or international organization:

The role of national or international non-governmental organizations draws the attention of many of the foreign language pre-service teachers in preventing violence against children. It has been stated that the most basic reason for the existence of these organizations is to provide all kinds of assistance in order to ensure that people live in more comfortable and equal conditions, and to help in the establishment of security and peace. As a matter of fact, it has been stated that they have a great role in meeting the education and basic needs of children. Moreover, they stated that it is of great importance for non-governmental organizations to have the right connections with all kinds of families, rich or poor, in order to prevent violence against children.

Perceptions of pre-service teachers about Code 4:

FLTC65: “Especially in poor and needy countries, national and international non-governmental organizations are of great importance for families and children. These institutions and foundations play a major role in preventing violence against children by providing necessary assistance to those in need.”

FLTC49: “Many international and national institutions such as the United Nations, World Health Organization, UNICEF and UNESCO help people in need of material or moral assistance in different geographies of the world. They provide basic needs and education services, especially for children and women. The services provided by these organizations for the most vulnerable beings, namely the children, play a major role in preventing violence.”

FLTC25: “As governments cannot meet the basic and educational needs of children in poor countries, national and international non-governmental organizations are trying to meet the necessary needs. They plan different organizations and programs to reduce violence against children for different reasons. Thanks to these contributions, I think that families are more conscious, and also learn how to treat their children.”

FLTC57: “Unfortunately, children and their families living in many countries around the world do not have the same opportunities and conditions. It is the main source of many problems in material and spiritual troubles. In the solution of these problems, the role of national and international organizations is very important. Among the main duties of these organizations are to ensure equality of rights among people, to ensure equality of basic needs and education. Therefore, I think that these organizations, which play an active role in preventing violence and abuse against children within or outside the family, are very important.”

Code 5: Raising as children to be good people:

Foreign language pre-service teachers` perceptions on the importance of raising children as a good person in preventing violence and abuse against children were determined. According to the pre-service teachers, they stated that it is very important to raise the future generations correctly and consciously since the family and conditions in which the child grows up will directly affect their future. A child who receives the necessary basic education and is educated in terms of human qualities neither stays silent when he is exposed to violence, nor is he inclined towards violence against others. It is thought by the pre-service teachers that children who have human virtues and make them an indispensable aspect of their character will have a healthier family structure in their future lives and that violence against children will be prevented by this means.

Perceptions of pre-service teachers about Code 5:

FLTC28: “It is very important for families to raise their children as healthy and virtuous individuals. Because, in a way, children are the reflections of their families. It is no coincidence that he reflects the treatment he sees at home outside. The role of families in the formation of children's characters is so great that they directly affect the adulthood of children, either negatively or positively.

FLTC08: “Children's elders, family environment, shapes their futures. A child who grows up with respect to ethical values will pass this on to his own children in the future. Therefore, children who are raised and educated as good people are in a natural process that prevents violence against children.”

FLTC17: “There is a saying in our country. “The child is both the hand and the tongue of the parent.” or “The child walks like his mother, speaks like his father.” As it can be understood from these proverbs, they learn what you show them. Children are actually imitations of their parents. I think if you raise your child to be a good and virtuous person, you will prevent not only violence against children, but also many bad traits and behaviors.”

FLTC63: “Raising healthy generations is one of the most important phenomena for a society. I believe that parents also have the first basic duty. A child who has received a good education and has universal humanitarian ethics will be one of the greatest role models of the next generation. This will ensure that violence against children is prevented or even eliminated in a natural process.”

Code 6: Teaching the child to resist violence:

Some foreign language pre-service teachers suggested that families teach their children how to resist violence. Thus, they thought that the child would be able to resist when violence was committed against him.

Perceptions of pre-service teachers about Code 6:

FLTC48: “Families can raise awareness of their children against violence and bullying. Children who know how to act in the event of any violence, bullying or abuse against them will be less negatively affected by these factors.”

FLTC07: “Children should be taught according to their age groups how to act if they are exposed to violence and abuse in some way. Children, especially parents, should be made aware of at school or through non-governmental organizations. In this way, the children can be prevented from being exposed to violence or abuse.”

FLTC12: “I think kids over a certain age can learn to protect themselves. Especially their families should help them in this regard. Any abuse or violence against a child by anyone can be prevented in this way. It even includes sibling violence in the family.”

Foreign language pre-service teachers emphasized the importance of legal rights and struggle to prevent violence against children. When Table 4 is examined, five recommendation codes were determined in the suggestions of the foreign language pre-service teachers regarding the function of laws in preventing violence against children.

Table 4
Recommendations Regarding Laws to Prevent Violence and Abuse against Children

Theme	Sub-theme	#	Recommendation codes	*f*
Preventing Violence Against Children	Laws	Code 1	Legal laws and sanctions	23
		Code 2	Regular trainings for families in public institutions	18
		Code 3	Improvement of socioeconomic conditions	11
		Code 4	Supporting and collaborating with national or international organizations	9
		Code 5	Increasing the number of pedagogues and providing psychological support services to children and their relatives who have been subjected to violence	6

Code 1: Legal laws and sanctions:

Pre-service teachers emphasized the importance of legal rights and struggle to prevent violence and abuse against children. The existence of protective, constructive, and deterrent laws belonging to the official state authority has been stated as a serious factor preventing violence and abuse against children. In this context, they primarily recommend arranging deterrent and heavy legal penalties.

Perceptions of pre-service teachers about Code 1:

FLTC40: “All kinds of violence, especially violence against children, can be prevented thanks to the laws that will be prepared under the power of the state authority. In addition, I believe that the rights and freedoms of children will also be protected. Likewise, I think that the state should have strict laws that prevent children's rights and child violence and abuse in order to protect its own future.”

FLTC19: “I think that sanctions against all forms of violence are insufficient. I believe that the harshest punishments will be more deterrent. In addition, severe sanctions should be applied to families who show violence. The children of people who have been subjected to violence by their families should be taken away and given to the protection of the state. A person who does not know love does not appreciate. A person who does not lose does not appreciate. If we want something good, there must be harsh sanctions.” He argues that removing the child from that family would be effective. Regarding criminal sanctions, imposing fines or imprisonment are among the different proposals.”

FLTC79: “Laws are made and enforced to protect people's freedoms. Where necessary, there is an obligation to punish for the sake of public peace. Violence against children is also within this scope. Their rights and freedoms should be protected by official laws and, where necessary, anyone who violates these laws should be punished. In this way, violence against children is prevented and other rights and freedoms of children are protected.”

Code 2: Regular trainings for families in public institutions:

Another recommendation code of pre-service teachers in order to prevent violence and abuse against children is the protection of state laws and regular trainings for families in public institutions within the framework of state laws. Because they stated that if the family, which is the institution where violence against children is most common, receives the necessary training under the planning of official laws, all kinds of violence, especially child violence, can be prevented to a large extent. They consider the necessity of regular and planned training in all kinds of official public institutions of the state.

Perceptions of pre-service teachers about Code 2:

FLTC77: “Family is the most important structure for raising healthy individuals. Education, which is one of the most basic needs of parents and children who make up this structure, should be met by the state. I believe that violence and abuse against children will definitely be prevented through regular and planned education within the framework of the law. In this context, the state should implement a planned educational organization in all public institutions.”

FLTC15: “Governments should give seminars and conferences periodically in all public institutions, especially to families who are financially in need. I think that parents who receive basic domestic education will pay more attention to the individual rights and freedoms of their children. Moreover, I believe that if these education programs are made compulsory, violence and abuse against children will decrease to lower levels.”

FLTC27: “I think that the most important regulation to be made in the laws of the state regarding violence and abuse against children is the education programs for the families. State-owned public institutions should conduct these seminars and conferences under the supervision of experts under necessary conditions.

Code 3: Improvement of socioeconomic conditions:

Pre-service teachers think that violence and abuse against children may also be related to the economic conditions of the society. In this context, they are of the opinion that increasing the level of social welfare will be a factor in preventing violence against children. They believe that the most important issue in increasing the welfare level will be thanks to the efficient laws of the governments regulating adequate social rights and freedoms.

Perceptions of pre-service teachers about Code 3:

FLTC33: “I think it is not surprising that a family that is in good financial standing is prosperous in many areas both financially and morally. After all, people or families get all their needs with the money they earn. These include shelter, food, health, and education. However, in the natural process, not everyone has the same material conditions, and many people find it difficult to meet even their basic needs. In this case, the power and laws of the state are needed. I think that if the state supports families enough, many domestic problems, especially child violence and abuse, will be solved by themselves.”

FLTC02: “States, governments or governorates… All of these structures exist for the welfare and peace of people. Their first task is to protect the welfare of the people who are their citizens. In addition, these bodies should help them meet at least the basic needs that every person has. In a country where social justice is ensured, I do not think that any type of violence, especially child abuse and violence, can be exercised except for some extreme cases.”

FLTC18: “Many problems are solved by themselves when the socioeconomic level and opportunities of a society are high. Moreover, I believe that with the increase in the level of education in parallel with the welfare level, violence against children will disappear. I believe that governments should implement just and constructive laws so that these conditions can be enjoyed by everyone in the society.”

Code 4: Supporting and collaborating with national or international organizations:

Another code that pre-service teachers emphasize is that states support national or international organizations and make joint plans with these organizations. They thought that this type of planning and organization was important in preventing violence and abuse against children. They stated that especially the countries with a high level of welfare can help other countries with a low level of welfare through international non-governmental organizations.

Perceptions of pre-service teachers about Code 4:

FLTC70: “Not every country in the world has very strong governments or good facilities. Therefore, reaching people in need and meeting their basic needs can be very difficult for these countries. Children, who are practically the most vulnerable, come first among the parties that need help the most. As a matter of fact, children in poor towns are exposed to more violence and abuse. For this reason, governments of poor countries should give more support to national or international non-governmental organizations and work together in preventing violence against children.”

FLTC47: “I believe that everything in our life has a reward, and we have duties as human beings. It is a valuable ethical value that the rich help the poor or meet this need for them in case of need. Unfortunately, many innocent children in the world are exposed to violence and abuse. Most of them live in poor countries. Thanks to the work and planning of national and international humanitarian organizations, violence against children is prevented to some extent. For this reason, I think that the biggest aid that rich states will give to needy countries will be through such non-governmental organizations, and as a result, violence against children will be prevented to a large extent."

FLTC61: "Many national and international institutions, foundations and similar structures work to prevent violence against children and children in many different countries of the world. In their states, planned and joint work with these organizations is required. These humanitarian organizations, which receive the support of the state, can fight against child violence and abuse more effectively."

Code 5: Increasing the number of pedagogues and providing psychological support services to children and their relatives who experienced violence:

Finally, foreign language pre-service teachers think that providing psychological support services to children who are exposed to violence and their relatives as an intervention program can be an important step in preventing violence. In addition, they state that increasing the number of pedagogues in many private or public institutions across the country would be effective. It has been stated that the majority of experts in the field take an active role in conveying and announcing the right message.

Perceptions of pre-service teachers about Code 5:

FLTC43: "A measure to be taken to prevent violence against children is the presence of experts in their field. There is a need for expert pedagogue staff to raise awareness of people, families and even children. Sometimes wrong advice or a cultural custom takes violence to different dimensions. In order to prevent this, I think that violence and abuse against children will decrease thanks to the delivery of the right messages to the society by experts in the field, under the control of the state and supported by the law."

FLTC51: "I think the messages that experts in the field will give to the public are very important. Many times, people do not even share their problems with their family or friends. After these growing problems, most of the time, violence is recreated against either himself or his environment. Children who are more vulnerable to this violence and abuse are particularly affected. In addition, violence damages not only the person, but also the people living with him/her, both materially and morally. The help of pedagogues is needed to compensate for these problems. The greatest assistance of the state to victims of violence and their relatives is to train and employ people who can solve their problems."

Foreign language pre-service teachers emphasized the importance of national and international non-governmental organizations as another sub-theme in order to prevent violence and abuse against children. When Table 5 is examined, three recommendation codes were determined in the suggestions of the foreign language pre-service teachers regarding the function of national and international non-governmental organizations in preventing violence and abuse against children.

Table 5

Recommendations for National and International Non-Governmental Organizations in Preventing Violence and Abuse against Children

Theme	Sub-theme	#	Recommendation codes	*f*
Preventing Violence Against Children	National and International Non-Governmental Organizations	Code 1	Recognition and promotion of national and international organizations	34
		Code 2	Benefiting from the experience of national and international organizations	19
		Code 3	Diversification and support of national aid agencies	7

Code 1: Recognition and promotion of national and international organizations:

Pre-service teachers emphasized the importance of National and International Non-Governmental Organizations and the struggle to prevent violence and abuse against children. Non-governmental organizations are defined as organizations that operate independently and continue their activities in line with legal, social, environmental, and cultural goals that are outside of official institutions. There are many independent national and international humanitarian organizations in the world. The main duty of these organizations is to work for the continuation of human rights and freedoms. It was emphasized that the recognition and promotion of these institutions both by the country's government and the society could play a role in preventing violence against children.

Perceptions of pre-service teachers about Code 1:

FLTC60: “There are many international aid organizations and non-governmental organizations in the world. These institutions work for the fundamental rights and freedoms of people. I think that the recognition of these institutions by both governments and the society, especially in regions in need of assistance, and knowing how to benefit from these institutions will play a role in reducing violence against children.”

FLTC10: “Many charities operate in our country. Each aid organization has different duties and areas of attention. Some work on energy and agriculture, while others work for children's rights and freedoms. I believe that these organizations should be recognized and promoted correctly in solving the problems of both the state administration and the people. These organizations provide both material and moral assistance to families in the prevention of violence and abuse against children. Therefore, it is necessary to bring families or children who have experienced violence together with these organizations.”

FLTC11: “Promoting aid organizations in the world and in our country, explaining to the society exactly what their areas of influence are and promoting them will not only prevent violence against children, but will also benefit in many different subjects and fields.”

FLTC44: “Non-governmental organizations are institutions that operate both nationally and internationally. Each of these institutions serves different purposes, but I think the common aspect of all of them is to protect human rights and freedoms and to provide an equal life. The correct recognition of the organizations by the families will also ensure that they serve in accordance with their purpose. I believe that violence will decrease when the institutions that work and make organizations for the prevention of all kinds of violence and abuse against children are introduced to the society.”

Code 2: Benefiting from the experience of national and international organizations:

Pre-service teachers stated that the knowledge and experience gained by National and International Non-Governmental Organizations in different geographies are used in their own country or in other countries in order to prevent violence against children. Although different cultures have different customs and rules, they emphasized that these experiences can be gathered together when the common issue is people's rights and freedoms. The government and its administrators stated that they would be advantageous in solving problems and preventing abuse against children in this respect.

Perceptions of pre-service teachers about Code 2:

FLTC16: “Non-governmental organizations work not only in one country, but also in many countries of the world. Every event they encounter develops themselves against an event they will encounter in another geography. In this case, the country administration can also benefit from the different experiences of these institutions and organizations. In this way, a faster way can be achieved in the prevention of violence against children."

FLTC38: "I think it would be beneficial to share the help and experience of national or international non-governmental organizations in order to prevent violence and abuse against children in our country. State authorities can cooperate more closely with these institutions and be more successful in preventing violence."

FLTC67: "NGOs help different cultures and peoples all over the world. Therefore, I believe that there is a serious pool of experience related to whom to help on what subject and in what way. I am of the opinion that it is an important step in finding a solution that governments or other national institutions benefit from the experiences gathered in this pool in preventing violence against children."

Code 3: Diversification and support of national aid agencies.

Another code that the foreign language pre-service teachers emphasized was that it would be beneficial to prevent violence against children by diversifying national humanitarian aid institutions in different fields and at the same time to respond to more specific problems and supporting them both in the eyes of the society and the state. As there are many non-governmental organizations in the world, every country has its own independent non-governmental organizations, foundations, and similar humanitarian aid organizations. It has been emphasized that the increase in the number of these institutions and the sharing of various duties will facilitate the solution of the problems.

Perceptions of pre-service teachers about Code 3:

FLTC32: "I believe that increasing the number of national humanitarian institutions or non-governmental organizations will be beneficial for society in every field. These and similar institutions help people's basic needs and needs in different ways. For example, violence against children is not actually a single issue. In other words, there are family, society, culture, living conditions and many other factors in the solution of the problem. Perhaps having different institutions addressing different aspects of the same problem will make the solution easier. For this reason, I think that the support of state officials and even people with good financial status will eliminate violence and abuse against children."

FLTC22: "There are rich and prosperous people as well as poor people in our country. I think that the national humanitarian institutions and foundations that will be established thanks to our government and generous people who want to help people will eliminate violence against children. It is obvious that many different problems will be solved with the training and other aids these foundations and non-governmental organizations provide."

FLTC81: "My father works at a government outreach platform. Many times, with my father, I participate in humanitarian aid organizations organized by this platform and work voluntarily. According to these little experiences I have had, people have very different problems and lives. During these experiences, I realized that the more the number and types of this and similar help platforms, the faster the needs and problems of people will be solved. In particular, I witnessed the cases of violence and abuse against children. I would like to emphasize that the multitude and diversity of national and international non-governmental organizations and their control and support by the current government and administrators are very important in preventing this and similar incidents of violence and abuse."

Foreign language pre-service teachers emphasized the importance of school and teacher as another sub-theme in order to prevent violence and abuse against children. When Table 6 is examined, six recommendation codes were determined in the suggestions of the pre-service teachers regarding the function of school and teacher elements in preventing violence and abuse against children.

Table 6

Recommendations Regarding School & Teacher in Preventing Violence and Abuse against Children

Theme	Sub-theme	#	Recommendation codes	*f*
Preventing Violence Against Children	School - Teacher	Code 1	Effective communication training and empathy with children	18
		Code 2	Educating teachers about violence	11
		Code 3	Recognizing/reacting to violence	9
		Code 4	Employment of individuals suitable for the teaching profession	7
		Code 5	Family educating schools	5
		Code 6	Children's access to school counselor	4

Code 1: Effective communication and empathy training with children:

According to pre-service teachers, teachers who are successful in communication skills establish more sincere relationships with their students. In this way, they stated that teaching and learning processes are more enjoyable and more beneficial in terms of getting to know the student with different aspects. It is important that teachers, who interact with children throughout the day, use effective communication methods. As a matter of fact, teachers need to be able to communicate correctly with students in order for the students to be more successful and self-confident, as well as to identify different needs and problems of students. Pre-service teachers expect teachers to be able to empathize with children, respect individual differences, and use problem-solving skills. In this regard, it is recommended that teachers undergo the necessary training. It has been stated that thanks to the trainings received, a high perception will be formed in the prevention of violence against children.

Perceptions of pre-service teachers about Code 1:

FLTC05: “The teacher as a role model is a very important value in itself. I think that the enrichment of this value will depend on the communication between the students and the teacher in the teaching and learning processes. A strong teacher figure in the student's world positively affects the student both in terms of lessons and ethically. I think it is obvious that a strong and reliable teacher figure is also important in preventing violence and abuse, which is a problem that a student may experience in his private life or at school.”

FLTC64: “Teachers were once students, too, and have extensive experience in this regard. It will be easier for students to empathize as they will understand their problems with their past experiences. However, not every teacher can establish the right empathy and right communication with their students. For this reason, I think that the difference in communication training that teachers will receive is very important for both themselves, and their students. I believe that teachers who can better understand their students through proper communication and empathy will be able to detect and intervene when they are exposed to violence and abuse.”

FLTC37: “In our culture, teachers come after parents. Especially during the primary and secondary school years, teachers have a great ethical and moral influence on students. In addition to the education received at the university, teachers should improve themselves by taking extra trainings, especially under their ability to communicate or empathize with students in working life. In this way, they can understand and solve not only their students' problems in school lessons but also their personal problems. For example, I think they can identify a student who has been exposed to violence or abuse faster and prevent this by making the necessary interventions.”

FLTC76: “Teachers have the status of being a consultant along with teaching. Teachers are people who show right and wrong according to the age and conditions of the student and teach ethical values and universal moral patterns. For this reason, a teacher who receives the right communication training and knows how to act according to the conditions can be the keys to the solution of all the problems of the students or the keys to the solution. Violence and abuse, which children suffer the most, are among these problems. I am of the opinion that a teacher who can have real empathy and has improved himself with extra training will play an active role in the solution of such a big end.”

Code 2: Training of teachers on violence:

Another obstacle that pre-service teachers focus on is that teachers should take classes and different trainings on violence and abuse against children, starting from their university years. It has been stated that the correct recognition of violence and abuse against a child facilitates the solution of the problem.

Perceptions of pre-service teachers about Code 2:

FLTC69: “I think that it will be possible for teachers who are together with children most of the day to fully understand and realize violence or abuse against children, especially with a training on this subject.”

FLTC52: “I would like to point out that the issue of violence and abuse, especially against children, is a subject that teachers should know and receive training on. A teacher who is adequately equipped about violence and abuse immediately recognizes a student who is exposed to this and implements what he needs to do.”

FLTC45: “Teachers are trained in many pedagogical subjects starting from university. I think one of the most important of these trainings is about violence and abuse against children. Because violence and abuse is a problem that negatively affects a student's entire education and training life and causes great wounds. There are many different negative effects, especially in young children. For this reason, I believe that teachers should undergo serious training on violence and abuse against children during and after their university education. In this way, it is possible to help students who are exposed to this problem.”

Code 3: Noticing violence / Reacting to violence:

Another proposition code that pre-service teachers emphasize is noticing violence against children and then reacting to this violence and abuse. Thanks to the necessary training and experience, the teacher should be able to recognize the violence or abuse against children. They stated that they should go after the problem and do their best for the student or students who are exposed to violence as much as they can within the framework of the rules.

Perceptions of pre-service teachers about Code 3:

FLTC41: “Teachers carry out their duties with a certain training and planning. With the education they have received and the experiences they have gained from both their colleagues and students over the years, they fight especially against violence and abuse against children. In my opinion, if the teacher performs his/her profession selflessly and eagerly, he/she will detect any type of violence against children in a very short time. Afterwards, he/she should implement all the necessary interventions within the framework of the determined rules. Thus, recognizing the problem and taking steps for a solution immediately has an important place in preventing violence and abuse.

FLTC01: “A well-educated teacher can identify a student in the classroom who has been exposed to violence or abuse in a short time. Afterwards, the teacher should do his best within his own sphere of influence. In this way, any type of violence or abuse against children will be detected as soon as possible, and most importantly, a solution will be reached.”

FLTC42: “The teacher observes the class from different perspectives during the course teaching. When he observes any problem in his students, he should be more sensitive to it. For example, when a student has a thought about being exposed to violence or abuse, he should immediately deal with this issue and reveal the situation. Then he should try to solve this problem as much as he can. In this way, it will help the student who is exposed to this violence or abuse.”

Code 4: Employment of individuals suitable for the teaching profession:

Foreign language pre-service teachers stated that in addition to the prevention of violence or abuse against children, another aspect of the teaching profession is that the teachers should internalize their duties in their job and do them eagerly. Pre-service teachers should also be selected from those who are appropriate in this regard. In parallel with this idea, they talked about the duties of the state.

Perceptions of pre-service teachers about Code 4:

FLTC05: “I don't think it's right for everyone who graduates from college to be employed as a teacher right away. I also believe that after becoming a teacher, the education and training of teachers should continue. However, I believe that violence and abuse against children will be prevented by employing qualified and sensitive teachers in schools.

FLTC82: “I believe that teachers have a great responsibility in preventing violence against children. Teaching is a very sacred profession in our country, and it has a very meaningful place in our culture, almost as much as parents. Therefore, the fact that teachers love their profession and have improved themselves has the potential to eliminate many problems. For this reason, I believe that the relevant state institutions should be very careful when employing teachers. A student who is exposed to violence or abuse is easily noticed by dedicated and conscious teachers. Then a helping hand will be given to them.”

FLTC29: “I think we should first review our education system in order to prevent violence and abuse against children because I do not believe that we are raising conscious individuals on this issue. In this regard, our state should take action and make changes in the curriculum, and if necessary, our teachers should be made more aware of this issue.” In his words, he recommends making plans to prevent violence in education programs.”

Code 5: Family-educating schools:

Another suggestion code of the students participating in the research is the relationship between family and school. The importance of the family was stated in the other suggestions and statements of the pre-service teachers. In addition, it has been suggested as a preventive factor for families to have relations with the school and teachers, and for the school to plan organizations to prevent violence and abuse against children.

Perceptions of pre-service teachers about Code 5:

FLTC58: “Family and school are the two most important elements in children's lives. Violence or abuse in any of these two elements causes great difficulties in the development of the child. For this reason, I think it is important that these two elements work together and act together. Schools can also help families on many different issues, especially violence against children, through educational organizations. In this way, I believe that parents will be more conscious thanks to the education they receive from school.”

FLTC24: “Schools should be a home of education not only for students but also for their families. Many parents cannot take care of their children enough due to different problems in today's world. Moreover, they may be in conflict most of the time because they cannot communicate properly with their children. After these and similar situations, the problem may turn into violence and abuse against children. In order not to face such a big problem, parents' relations with the school should be strengthened and educational organizations on different subjects should be organized within the schools.“

Code 6: Children's access to school counselor:

Finally, another code that foreign language pre-service teachers care about, within the sub-theme of school - teacher, in order to prevent violence and abuse against children, is to ensure that children reach the school counselor or the relevant unit. According to the statements of the novice teachers, although the teacher has reached this position by completing a certain education and training, he should not act alone on a very serious issue such as child violence and abuse. He/she should definitely cooperate with units such as school administration, school guidance service or school pedagogue. According to the pre-service teachers, thanks to the planning of the specialist in the school guidance service, the teacher assumes a more productive role in preventing violence against children.

Perceptions of pre-service teachers about Code 6:

FLTC82: “Violence and abuse against children is a very serious problem. Teachers are the first to notice and intervene in this situation which takes place in the family or in the school. But I think that teachers alone will not be enough in this regard. Because every teacher may not know how to behave in any situation. Therefore, the communication of both the teacher and the student with the school guidance service is very important. Only in this way can a big problem such as violence and abuse be solved.”

FLTC03: “I think that school guidance services have an important role to play in preventing violence against children. Because teachers do not have the equipment and training to solve such an important and complicated problem on their own. If a teacher detects a problem such as violence or abuse in any of his students, he must bring the matter to the school administration and the guidance service. In this way, these problems can be overcome more quickly and efficiently.”

Foreign language pre-service teachers emphasized the importance of society as another sub-theme in order to prevent violence and abuse against children. When Table 7 is examined, three recommendation codes were determined in the suggestions of the foreign language pre-service teachers regarding the function of society in preventing violence and abuse against children.

Table 7
Recommendations for the Society in Preventing Violence and Abuse against Children

Theme	Sub-theme		Recommendation codes	*n*
Preventing Violence Against Children	Society	Code 1	Planning of trainings that raise awareness of society	21
		Code 2	Social responsibility projects	16
		Code 3	Mental Health Community Support Services	4

Code 1: Planning of trainings that raise awareness of society:

Foreign language pre-service teachers emphasized the importance of awareness-raising trainings in the social context in order to prevent violence and abuse against children. They stated that the cultural perceptions of societies are not always correct and that these perceptions change only through educational activities, and it has an important place in solving the problem. In addition, they drew attention to the low level of education and cultural richness of some segments of the society due to different problems and stated that the solution to this problem could only be achieved through education.

Perceptions of pre-service teachers about Code 1:

FLTC09: “We live in the middle east in a country with different problems. Violence and abuse against children are, of course, among the important problems of our society. I believe that the fastest and most efficient way to solve this problem will be to raise awareness of our people about the issue, especially in regions with low financial status and welfare, by the help of the state and aid organizations.”

FLTC36: “Every society has its own cultural life and rules. Of course, these rules depend on past experiences and different factors. However, we cannot say that these rules and customs are always correct and beneficial. For this reason, relevant authorities should initiate an education campaign on a community basis and raise awareness of families against violence and abuse, especially about children.”

FLTC39: “I believe that the most effective way to prevent violence will be through education. I am having doubts about whether legal sanctions can be effective. Since our society is experiencing the obedience-punishment phase intensely, I believe that in every environment where the authority figure disappears, when people believe that they will not be punished, they will display violent behaviors again. For this reason, I think education is important in prevention of violence and abuse. Trainings should be organized in order to minimize the violence tendencies of parents, teachers and all individuals in the society.” He emphasized the importance of education in order to raise social awareness.”

Code 2: Social responsibility projects:

As another suggestion of the foreign language pre-service teachers in the social context, they suggest that official institutions or various non-governmental organizations conduct social projects on all kinds of issues that may lead to violence and abuse. They stated that these projects can provide the idea of valuing children appropriately, teach that violence cannot be a solution, and raise social awareness.

Perceptions of pre-service teachers about Code 2:

FLTC04: “I believe that one of the most important needs of the people of our country is of course education. I don't mean just schools here. I think that people of all ages in our society need education about social problems. For this reason, I believe that all kinds of violence, especially violence against children, will decrease and even disappear in time, thanks to the organization of social responsibility projects on a community basis with the help of all kinds of non-governmental organizations, especially our government."

FLTC73: "I believe that it will be very beneficial for both official authorities and aid organizations to carry out education and social responsibility projects to raise awareness of the problem of violence and abuse against children in regions where the welfare level is low. Thanks to the social projects organized, there will be an awareness and a healthy increase in consciousness in the society. In this way, it is possible to prevent violence against children."

FLTC06: "In my opinion, seminars, conferences and social responsibility projects should be organized at certain intervals to prevent violence and abuse against children, regardless of whether the society is rich or poor. I believe that it will be more effective in preventing child violence and abuse in the society if educational activities take part in the organizations to be organized by the authorized bodies of the state, non-governmental organizations and even many international institutions and foundations."

Code 3: Mental health community support services:

It was stated by the pre-service teachers that another important suggestion in preventing violence and abuse against children is at the point of psychological support. It has been stated that individuals who perpetrate violence against children must receive psychological support and be rehabilitated.

Perceptions of pre-service teachers about Code 3:

FLTC35: "The child or individuals in the society who are involved in violence and abuse against children should be rehabilitated; common and stereotyped beliefs should be reframed in order to improve society. For this, family psychotherapy services such as family health centers should be offered to the community." He expressed this suggestion in this way.

FLTC73: "I think the relevant organs of the state and related non-governmental organizations should make more efforts to support the mental health of the society. I think that compulsory education and mental health support will be provided to people who personally perpetrate violence and abuse, other than children and their relatives who have been exposed to violence or abuse, will prevent child violence and abuse. In addition, I would like to express that recognizing ways to solve problems in the social context without violence and making it a habit will be important in preventing violence."

Foreign language pre-service teachers emphasized the importance of the power of media, which is one of the biggest virtual powers of the global world, as another sub-theme in order to prevent violence and abuse against children. So much so that there are no borders, and all kinds of necessary and unnecessary information can be accessed in many different ways at any time, the power of the media, as seen in Table 8, has been determined as three recommendation codes for preventing violence and abuse against children.

Table 8
Recommendations Regarding Media Organs in Preventing Violence and Abuse against Children

Theme	Sub-theme		Recommendation codes	*f*
Preventing Violence Against Children	The power of Media	Code 1	Preventing violent content/videos	19
		Code 2	Active public spots / News	11
		Code 3	Awareness broadcast/programs	6

Code 1: Preventing violent broadcasts/videos:

Pre-service teachers stated that the media has a great positive effect as well as a negative effect in order to prevent violence and abuse against children. They talked about the negative effects of broadcasts, programs and videos on different media platforms that praise or encourage violence and its types. It has been stated that cyber violence and abuse, which is the biggest problem of recent times, has taken violence and abuse against children to a different dimension. They recommended that this great power of the media should be used in a positive way, that violent broadcasts should be removed and that violence under state control should be addressed in the media.

Perceptions of pre-service teachers about Code 1:

FLTC78: “The effect of media on violence and abuse is discussed in our country as well as all over the world. Broadcasts and programs that encourage or even endear violence must be brought under control. Many people can harm both themselves and those around them because of the videos they watch and the fake news. I believe that the state should have an organ to prevent them. Such publications should not be allowed in order to prevent violence against children.”

FLTC31: “I believe that media has both positive and negative effects in today's world. In my opinion, all violent programs and videos in the media and its organs should be removed immediately. For example, cyber violence and bullying, which have become a new problem, are at the forefront. Moreover, the relevant units of the state should take control of all written and visual broadcasts, especially those involving violence and abuse.”

FLTC56: “Maybe it will be a bit of a radical and harsh proposal, but I think it is urgently necessary to remove, block or ban violent broadcasts and videos that socially encourage violence and cause children to witness violence. With the introduction of the Internet into our lives, we see that children and young people are exposed to cyberbullying and violence on social media platforms and especially in online and offline areas through games. This negative face of the media has added another dimension to violence against children. In this context, I think that the relevant organs of the state and non-governmental organizations act more sensitively on this issue, which can be a hindering factor.”

Code 2: Active public service announcements / news:

In order to prevent violence against children, pre-service teachers often emphasized the importance of public service announcements about preventing violence and abuse against children in order to raise public awareness in the context of the media. In addition, they stated that the society's interest in news and news programs can be used as a tool to increase people's awareness against child violence and abuse.

Perceptions of pre-service teachers about Code 2:

FLTC80: “In fact, the media is an incredible power. I think the important thing is to use this power for the right purpose. On this occasion, advertisements and public service ads that will accentuate the place, importance, and innocence of the child in society should be spread in the mass media. Public service announcements and educational programs about violence and abuse should be supported.”

FLTC21“Effective public service announcements and awareness-raising programs about violence and abuse against children in the written and visual media should be implemented under the control of experts. Misperceptions in the society should be prevented, and besides adults, the high power of the media should be used for children of different ages and periods.

FLTC50: “Almost all of the people in our country definitely watch various news programs in the evenings. Adults, in particular, attach more importance to these programs. Educational and attention-grabbing publications on violence and abuse against children can be prepared for the contents of the news watched by all segments of the society at the same time. Perhaps people's awareness of this sensitive issue will increase unconsciously.”

Code 3: Awareness-raising broadcast/programs:

Another suggestion code of pre-service teachers regarding the power of the media is to increase the number of educational publications and programs and to engage in all kinds of written and visual activities related to raising public awareness.

Perceptions of pre-service teachers about Code 3:

FLTC54“There are programs and publications in the media that serve many different purposes. In this context, broadcasts and programs that inform the public about violence, abuse, children's rights play an active role in solving this problem.

FLTC26“The most positive aspect of the media is that it can reach people with different life conditions and perceptions in the society at the same time. This convenience should be used to explain, express, and inform the society about violence and abuse against children. Programs and training plans, which will be prepared under the control and supervision of pedagogues or doctors who are experts in their fields, will reach all people in the society thanks to the media. In this way, violence and abuse will decrease in a society with an increased level of awareness.”

Foreign language pre-service teachers emphasized the importance of drama and art as the last sub-theme in order to prevent violence and abuse against children. When Table 9 is examined, two recommendation codes were determined in the suggestions of the foreign language pre-service teachers regarding the function of society in preventing violence and abuse against children.

Table 9
Recommendations Regarding Art and Cinema in Preventing Violence and Abuse against Children

Theme	Sub-theme		Recommendation codes	*f*
Preventing Violence Against Children	Drama and Art	Code 1	Awareness-raising Theatre/Cinema/Short film	11
		Code 2	Emphasis / reminder in all kinds of artistic activities	5

Code 1: Awareness-raising theatre/Cinema/Short film:

According to some foreign language pre-service teachers, drama activities that will raise awareness about violence will play a role in preventing violence against children. It is recommended to raise awareness of the society through theatre, cinema, and short films.

Perceptions of pre-service teachers about Code 1:

FLTC54: “Most people like to watch all kinds of movies, especially on television. At this point, it is possible to place messages about violence and abuse against children and how this can be prevented. In this way, people get the right messages and awareness about the subject in many movies they watch.”

FLTC26: “The issues of violence and abuse against children can be covered in drama activities that are admired and followed in society such as theater and cinema. The awareness level of the audience can be increased. In this way, an awareness is created in the society regarding the issue, and it is possible to go a long way in preventing violence against children.”

FLTC59: “Everyone has a favorite movie. Many people are influenced by the movies they watch for days. Violence and abuse against children can be processed effectively in short films that people watch for fun and for educational purposes. Movies that give a message about the subject can be recommended at home, at school and by experts and encouraged for people to watch. In this way, this serious problem can be solved in every part of the society.”

Code 2: Emphasis / reminder in all kinds of drama activities:

Emphasizing violence and abuse against children in organizations such as painting, music, handicrafts, and symposiums that bring together many different segments of the society has been expressed as an argument with a preventive dimension.

Perceptions of pre-service teachers about Code 2:

FLTC23: “Almost all people come together for different purposes. Drama activities are at the forefront of these. People can receive messages that promote or inform violence and abuse against children in many different artistic environments such as painting, music, and exhibitions. As a matter of fact, after a while, people's awareness levels will increase, and they will approach the subject more sensitively and interestedly.

FLTC46: “. In fact, I think that in society in general, everyone comes together with their equals in many different artistic activities. People participate in various exhibitions, concerts, and symposiums such as painting and handicrafts at work, at school, in the circle of friends and in other groups. With minor changes and additions to the content of these activities, the participants' perceptions of violence and abuse against children should be directed positively. Afterwards, it will become a sensitive issue of society and will be a factor in preventing violence and abuse.”

Discussion

In the research, the suggestions of the foreign language pre-service teachers regarding the prevention of violence and abuse against children were examined from a holistic perspective and the findings were stated to include the opinions and suggestions of all students participating in the research. As a result of the research, it has been determined that the foreign language pre-service teachers have the most suggestions for the family, official laws, national and international non-governmental organizations, school and teacher, society, media and drama and art, respectively, in preventing violence and abuse against children. In addition, most of the pre-service teachers stated that training should be provided for parents, national and international organizations, non-governmental organizations, school administration and teachers, and moreover, all members of the society in order to prevent violence and abuse against children.

The foreign language pre-service teachers participating in the study interpreted the issue of violence and abuse against children as a multifaceted and complex social problem. It has been clearly demonstrated that solutions and suggestions cover many different factors, institutions, and organizations. Many foreign language pre-service teachers expressed the view that the state and those responsible for the administration should be sensitive about violence and abuse against children, and that deterrent legal arrangements should be made in this sense. It is important for pre-service teachers to emphasize the importance of the "education" factor in preventing violence against children. It has been stated that state administrators, national and international organizations, non-governmental organizations must support, and joint planning should be done. Moreover, these trainings should include lectures, educational seminars, etc., on preventing violence against children, especially during the university education of pre-service teachers and in their professional life. It has been interpreted that they may be inclined to improve themselves. In the study, we come across the family, which is the core of social structure, as the most prominent unit. The social status and welfare level of the family has an important place in preventing violence and abuse against children. Since families with a high level of consciousness and meeting their basic needs will have a positive impact on society, the state has been expressed as an institution that should be supported by all kinds of non-governmental organizations and schools and teacher. In addition, its effects are clearly seen in the media and art. It is expected that the awareness of the society will increase, and a more sensitive approach will be displayed, thanks to the selection of the right communication channels, and effective propaganda and messages on the prevention of violence against children on common platforms.

As a result of the research, it was determined that the foreign language pre-service teachers had the most family-oriented suggestions to prevent violence and abuse against children. They also argued that awareness-raising information should be given to mothers and fathers within the family. Foreign language pre-service teachers think that violence is a phenomenon that usually starts in the family, and therefore, training and informing in the context of parent-child communication to be carried out for parents or people responsible for children's care in the family can have an important role in preventing violence. It was also stated that these trainings and social aids should be realized under the structure of national and international institutions, non-governmental organizations and the school and the relevant state institutions. In addition, they stated that various situations such as parents' keeping strong communication with the child, being a good example to the child and being empathetic are also important in preventing violence against the child.

This point of view of foreign language pre-service teachers are also supported by the literature. The family, besides being the most basic building block of the society, is an institution where the child first interacts with the people around and his needs are met. The family is a very important structure that expresses different meanings in almost all cultures. Most importantly, the child's relationship with the family is very important in terms of psychological and social development as they are aging. Therefore, the communication that the child establishes with his/her family in this process can form the basis of his/her future life (Howe, 2007; McCoy et al., 2020). In the developmental process of their children, parents may see violence as a behavior change mechanism (Deb & Modak, 2010). Canadian psychologist Albert Bandura, one of the important representatives of social learning theory, argued that individuals learn many behaviors by observing their social environment. Within the framework of this theory, it can be said that individuals can learn many positive behaviors such as helping, solidarity and showing love, and negative behaviors such as violence and aggression by observing their environment (Bandura, 2002; Izaguirre & Calvete, 2017; Kitzinger, 2004). For this reason, informative and awareness-raising trainings for families, effective parent-child communication, developmental psychology, problem-solving skills, behavior management, healthy child raising, and institutions and organizations from which they can get help can be important in preventing violence against children (McCoy et al. , 2020; Durrant et al., 2017; Rubenstein & Stark, 2017; Whitzman, 2012; Holt et al., 2008; Howe, 2007) because the child can show the violent behavior he learned in the family against his peers in his school or neighborhood. In addition, it can be said that educational studies to be conducted based on the fact that violent behavior is a "learnable behavior" (Gil, 2017; Chiang, et al., 2016).

Another result obtained in the study is that foreign language pre-service teachers have suggestions regarding laws to prevent violence and abuse against children. They also stated that among the regulations, those to be made in the legal field are required the most. Pre-service teachers stated that one of the most important reasons for the prevalence of violence in society in the context of laws is that legal sanctions are not deterrent. In this context, they think that deterrent arrangements to be made in the legal field can be effective in preventing violence and abuse against children. In addition, the opinion that the arrangements to be made within the education system could be effective was expressed by the pre-service teachers. Moreover, it was emphasized that the state should work together with national and international organizations and non-governmental organizations for these regulations and trainings. As a matter of fact, not every country may be good at the level of social and economic welfare. In this case, there is the opinion that it will be more efficient for aid organizations and relevant organs of the state to work together. Policies, educational services, and legal regulations to be carried out by governments considering the best interests of the child can constitute an important dimension in preventing violence against children (Sabol et al., 2004; Whitzman, 2012; World Health Organization, 2019) because policies and legal regulations are a coercive force on society.

Another remarkable result of the research is the important role of national and international organizations, non-governmental organizations, and their affiliated official and private structures such as foundations, associations, etc. in preventing violence and abuse against children. They openly stated that these and similar institutions and organizations, especially in countries that cannot reach a certain level of welfare in terms of economic and social security, should be organized, and planned in common platforms with the current government, especially for families. Moreover, it is thought that the knowledge, experience, and skills acquired by international organizations in different countries play an important role in preventing violence and abuse against children. It has been determined that national and international organizations play an important role in increasing the material and moral level of the society, especially through educational organizations, seminars, conferences, social and economic family aids. As a matter of fact, in many parts of the world, trainings on many different subjects, especially humanitarian aid, are provided to families free of charge by national and international organizations. In addition, thanks to the power and capabilities of these institutions and organizations to penetrate other social and economic problems of the society, a natural solution chain effect will emerge in the solution of violence and abuse against children (Daugirdas, 2019; Walker-Descartes et al., 2021; World Health Organization, 2019). National and international organizations that are socially and economically supported and involved in the solution of different social problems will make an important contribution to the prevention of all kinds of violence and abuse (Ferguson et al., 2007; Guedes et al., 2016; McLeigh & Taylor, 2020;).

According to another result of the research, it was determined that foreign language pre-service teachers have suggestions in the context of school and teacher in preventing violence and abuse against children. In general, children between the ages of 6 and 18 are educated in schools within the scope of compulsory education. The school environment and teachers, where the child spends an important part of his daily life, have an important place in the development of the child (Becker, 2017; Coleman, 2018). In this context, pre-service teachers emphasized that the share of school and teachers is important in preventing violence against children. They stated that in-service training programs to be carried out for teachers in schools and training programs to be carried out with parents can be effective in preventing violence against children. They also stated that teachers' having effective communication skills and awareness of violence can be effective in preventing violence and abuse against children. In addition, foreign language pre-service teachers stated that it would be beneficial to carry out joint educational work and social responsibility projects with national and international organizations regarding the violence and abuse of teachers against children.

Based on the fact that violence has a learnable dimension, we can say that preventing violence can also be learned (Durrant et al., 2017; McCoy et al., 2020; Rubenstein, & Stark, 2017). In this respect, the knowledge, skills, and awareness of teachers, who play an important role in the development of children, are important (Wilson et al., 2011). According to a study by Rebecca B. Silver et al., it was observed that students consult their families or teachers when faced with a negative situation (Silver et al., 2005). In this respect, teachers' knowledge of violence behaviors and effects, their ability to recognize violence and their sensitivity to prevent violence are important dimensions in preventing violence against children (Baginsky, 2003; Fayez et al., 2014; Kenny, 2001; Walsh et al., 2008) because teachers are the people who can directly affect the development of children (McKee & Dillenburger, (2012). In addition, the trainings of teachers about violence against children for parents can be an important opportunity to prevent violence against children (Kula & Akbulut, 2021).

In the study, foreign language pre-service teachers also emphasized the importance of school administration in preventing violence and abuse against children or children. As a result, the problem should be multifaceted and, in its solution, the teacher should follow the rules determined by the relevant official body, not alone (Coleman, 2018). As a matter of fact, it is an obligatory duty for the teacher to report these and similar issues to the school administration. Moreover, different complications of the problem are eliminated with the effect of the administration in the solution phase (Devries et al., 2013). In this context, it has been suggested by the pre-service teachers that the teacher can apply for the help of national and international organizations and non-governmental organizations, under the supervision of the school administration. As a matter of fact, in the countries with socioeconomic and similar problems, national and international institutions carry out studies and activities in partnership with schools and teachers in order to prevent violence and abuse against children (Davis, 2003; Deb & Modak, 2010; World Health Organization, 2011).

In addition to this partnership, a case that pre-service teachers emphasized is their views on psychological counseling and guidance services in schools in preventing violence and abuse against children. It has been stated that it is important to bring together the students and the service officials and to meet the students at the school under the control of the school administration and in the periodic meetings of the staff members. However, depending on the geography, the inadequacy of psychological counseling and guidance services or the inadequacy of the expert staff in schools is another situation that needs to be discussed. Psychological counseling and guidance services in schools provide personal, educational, and professional services in order to realize the physical, psychological and social development of students in a healthy way (Wright, 2011). They can take an important place in preventing violence against children with psycho-education, group guidance, classroom guidance and individual guidance activities they will carry out with students, teachers and administrators at school (Low et al., 2013; Schalkwyk & Sit, 2013). In this context, the effectiveness of psychological counseling and guidance services in schools is an important factor in preventing violence against children (Amatea & Clark, 2005; Bryan & Holcomb-McCoy, 2007).

Another result of the research is that foreign language pre-service teachers have inclusive suggestions in the context of society to prevent violence and abuse against children. The first point that pre-service teachers drew attention to was the difference in the traditional culture and customs of the geography they lived in. Although they found the experiences of the past useful, they stated that traditional understandings that do not fit with today's life or stereotypes may be insufficient to prevent violence and abuse against children. Moreover, they emphasized this change and the organizations that create education and awareness in preventing violence and abuse against children. As a matter of fact, foreign language pre-service teachers think that raising awareness of all segments of society about violence and receiving education can be effective in preventing violence against children. In this context, the relevant institutions of the state, national and international organizations and non-governmental organizations and all members of the society should be informed about violence and abuse against children, and sensitivity to the issue should be increased on the basis of the society, through the organizations and trainings to be held in cooperation. In addition, it has been determined that there are opinions on the realization of social responsibility projects to prevent violence and abuse and to raise awareness, which will be organized with non-governmental organizations, especially with state support, and to strengthen problem-solving skills.

In the study, it was seen that foreign language pre-service teachers have different suggestions regarding the media in preventing violence and abuse against children. The first point that pre-service teachers draw attention is that due to the negative effects of broadcasts, programs and videos on different media platforms that praise and encourage violence and abuse, the relevant official and private bodies should take action, and all broadcasts with this content should be removed as soon as possible. In this context, foreign language pre-service teachers stated that the presence of awareness-raising public service ads and broadcasts on preventing violence and abuse against children can be effective in preventing violence and abuse against children.

Especially with the development and spread of telecommunication tools, the media has become a phenomenon that directly penetrates the life of people, therefore family and society. Individuals can acquire new knowledge and skills through television, newspapers, magazines and communication technologies, especially mobile phones, computers, and internet/virtual platforms. However, the media and its organs can negatively affect the lives of individuals, especially children and youth, in different situations and conditions (Al-Nasrawi, 2021). By this means, it causes many new problems to occur or the problems to evolve in a negative way and become unsolvable. The biggest example of this evolution is cyber violence, or in other words, cyberbullying (Bhat, 2008). Physical violence leaves its place to cyber violence and abuse in children, causing serious damage in the spiritual world and personal development of children and young people (Nagle et al., 2017). Thanks to the games and the visuals on the platforms that serve different purposes, it is possible for individuals to accept and learn the elements of violence and abuse as normal. In this context, the media and its organs have an important place in preventing violence and abuse against children (Kardefelt-Winther & Maternowska, 2020). It is important to organize all written and visual content in the media in accordance with the healthy development of individuals. In particular, it is important for the healthy development of children to supervise and regulate written and visual programs, social media platforms, and online or offline areas with video/games and similar content for children and adolescents (Hestermann, 2008). In addition, the importance of broadcasting educational and awareness-raising public service announcements by foreign language pre-service teachers in preventing violence and abuse against children was emphasized.

Finally, it was seen in the study that foreign language pre-service teachers had suggestions in the context of drama and art in preventing violence and abuse against children. The pre-service teachers stated that the theater and films that will inform and raise awareness about preventing violence and abuse against children can be effective. People from almost all walks of life and age follow movies and TV series. They suggested that awareness-raising messages could be given in the content of these works to prevent violence and abuse against children. In addition, it is important that cartoons and similar movies that children and adolescents watch with pleasure contain messages with content on preventing violence and abuse against children (Rasmussen, 2014). As mentioned in social learning theory, it is known that all children, especially young children, are more interested in cartoon heroes than real life models, and therefore these heroes are more effective in the learning process (Bandura, 2002). In addition, another point that foreign language pre-service teachers draw attention is that there may be informative messages and visuals about informing about and preventing violence and abuse against children in the content of programs and organizations such as exhibitions, seminars, concerts where people from all walks of life come together. In this context, it is necessary to benefit from different artistic platforms that have a high impact on society in order to prevent violence and abuse against children.

Conclusions

The pre-service teachers expressed their perceptions about violence and abuse against children, and they emphasized on the importance of some organs more than the others. But still, they think that these organs should have functions to prevent abuse and violence. They emphasize on the effectiveness of family above all others. It seems they consider the family the first institution to combat these problems. They also underline the importance of laws for prevention, which seems to be an important problem because they may not be implemented effectively. They also see national and international non-governmental organizations as important, and it may be because of the reason that they would like to fill the gap that is caused by poor application of the laws. The next thing that they underline as important is the school and the teacher in relation to it. They also bring society and media to the fore in order to combat the problem. In the end, some of them emphasized on art and cinema for prevention.

In this study, perceptions and suggestions of foreign language pre-service teachers on preventing violence and abuse against children were examined. The study is limited to 82 first-year and second-year foreign language students studying at Tishk International University Faculty of Education and voluntarily agreeing to participate in the research. In addition, the results of the research are limited to the qualifications measured by the "Recommendations Form for the Prevention of Violence and Abuse Against Children" prepared to determine the views of pre-service teachers on preventing violence and abuse against children. In addition, only the interview method among the qualitative data collection tools was used in the research. This situation constitutes one of the limitations of the study.

Suggestions

It is noteworthy that there is not enough research on the subject in the literature, especially in this geography. For this reason, it is thought that there is a need for new studies with different working groups and different methods on the subject.

Providing courses and trainings to all pre-service teachers in education faculties that will provide knowledge, skills and awareness about violence and abuse against children by expert personnel and placing them in the curriculum.

Organizing projects that will involve all pre-service teachers in education faculties, revealing social responsibility and awareness regarding violence and abuse against children,

Relevant bodies of the state and pre-service teachers come together in projects and platforms to prevent violence and abuse against children.

It is recommended that students studying in education faculties come together with national or international organizations and relevant non-governmental organizations in projects and platforms that prevent violence and abuse against children, under the supervision and control of the university administration, and organize training programs that increase awareness and skills on the subject.

References

Adams, A. E., Sullivan, C. M., Bybee, D., & Greeson, M. R. (2008). Development of the scale of economic abuse. Violence Against Women, *14*(5), 563-588. https://doi.org/10.1177%2F1077801208315529

Al-Nasrawi, S. (2021). "Combating cyber violence against women and girls: an overview of the legislative and policy reforms in the Arab region", Bailey, J., Flynn, A., & Henry, N. (Ed.) The Emerald International Handbook of Technology-Facilitated Violence and Abuse (Emerald Studies in Digital Crime, Technology and Social Harms) (pp. 493-512). Emerald Publishing. https://doi.org/10.1108/978-1-83982-848-520211037

Amatea, E. S., & Clark, M. A. (2005). Changing schools, changing counselors: A qualitative study of school administrators' conceptions of the school counselor role. *Professional School Counseling*, *9*(1). https://doi.org/10.1177%2F2156759X0500900101

Baginsky, M. (2003). Newly qualified teachers and child protection: A survey of their views, training and experiences. *Child Abuse Review*, *12*(2), 119-127. https://doi.org/10.1002/car.783

Bahar, G., & Bahar, A. (2009). Çocuk İstismarı ve İhmali: Bir Gözden Geçirme [Child abuse and neglect: A review]. *Fırat Sağlık Hizmetleri Dergisi, 4* (12).

Bandura, A. (2002). Social cognitive theory in cultural context. *Applied Psychology*, *51*(2), 269-290. https://doi.org/10.1111/1464-0597.00092

Bayyurt, Y. (2006). Non-native English language teachers' perspective on culture in English as a foreign language classroom. *Teacher Development*, *10*(2), 233-247. https://doi.org/10.1080/13664530600773366

Bazeley, P. (2013). *Qualitative data analysis: Practical strategies*. Sage Publications. https://hdl.handle.net/1959.7/uws:59691

Becker, H. S. (1952). Social-class variations in the teacher-pupil relationship. *The Journal of Educational Sociology*, *25*(8), 451-465.

Bennett, S., Hart, S. N., & Svevo-Cianci, K. A. (2009). The need for a General Comment for Article 19 of the UN Convention on the Rights of the Child: Toward enlightenment and progress for child protection. *Child Abuse & Neglect*, *33*(11), 783-790. https://doi.org/10.1016/j.chiabu.2009.09.007

Bhat, C. S. (2008). Cyber bullying: Overview and strategies for school counsellors, guidance officers, and all school personnel. *Journal of Psychologists and Counsellors in Schools*, *18*(1), 53-66. https://doi.org/10.1375/ajgc.18.1.53

Borg, S. (2006). The distinctive characteristics of foreign language teachers. *Language Teaching Research*, *10*(1), 3-31. https://doi.org/10.1191%2F1362168806lr182oa

Bryan, J., & Holcomb-McCoy, C. (2007). An examination of school counselor involvement in school-family-community partnerships. *Professional School Counseling*, *10*(5). https://doi.org/10.1177%2F2156759X0701000501

Byram, M. (1989). *Cultural Studies in Foreign Language Education* (Vol. 46). Multilingual Matters.

Celik, B., & Yildiz, Y. (2019). The role of foreign language culture on teaching the language and learner motivation. *International Journal of Social Sciences & Educational Studies*, *5*(4), 150-161. https://doi.org/10.23918/ijsses.v5i4p150

Chiang, L. F., Kress, H., Sumner, S. A., Gleckel, J., Kawemama, P., & Gordon, R. N. (2016). Violence Against Children Surveys (VACS): Towards a global surveillance system. *Injury Prevention*, *22*(Suppl 1). http://dx.doi.org/10.1136/injuryprev-2015-041820

Coleman, J. S. (2018). *Parents, their children, and schools*. Routledge.

Cookson, T. P., Fuentes, L., Saxena, A. S., & Jha, S. (2021). Programmatic norms change to eliminate violence against children: insights for practitioners and researchers from a UNICEF global mapping study. *Global Public Health*, *16*(6), 870-881. https://doi.org/10.1080/17441692.2020.1839931

Corby, B. (2005). *Child abuse*. Open University Press.

Daugirdas, K. (2019). Reputation as a disciplinarian of international organizations. *American Journal of International Law*, *113*(2), 221-271. https://doi.org/10.1017/ajil.2018.122

Davis, H. A. (2003). Conceptualizing the role and influence of student-teacher relationships on children's social and cognitive development. *Educational Psychologist*, *38*(4), 207-234. https://doi.org/10.1207/S15326985EP3804_2

Deb, S., & Modak, S. (2010). prevalence of violence against children in families in Tripura and its relationship with socio-economic factors. *Journal of Injury and Violence Research*, *2*(1), 5. https://dx.doi.org/10.5249%2Fjivr.v2i1.31

Devries, K. M., Allen, E., Child, J. C., Walakira, E., Parkes, J., Elbourne, D., ... & Naker, D. (2013). The good school's toolkit to prevent violence against children in Ugandan primary schools: study protocol for a cluster randomized controlled trial. *Trials*, *14*(1), 1-9. https://doi.org/10.1186/1745-6215-14-232

Durrant, J., Plateau, D. P., Ateah, C. A., Holden, G. W., Barker, L. A., Stewart-Tufescu, A., ... & Ahmed, R. (2017). Parents' views of the relevance of a violence prevention program in high, medium, and low human development contexts. *International Journal of Behavioral Development*, *41*(4), 523-531. https://doi.org/10.1177%2F0165025416687415

Fayez, M., Takash, H. M., & Al-Zboon, E. K. (2014). Combating violence against children: Jordanian pre-service early childhood teachers' perceptions towards child abuse and neglect. *Early Child Development and Care*, *184*(9-10), 1485-1498. https://doi.org/10.1080/03004430.2014.901013

Ferguson, K. M., Wu, Q., Spruijt-Metz, D., & Dyrness, G. (2007). Outcomes evaluation in faith-based social services: Are we evaluating faith accurately? *Research on Social Work Practice*, *17*(2), 264-276. https://doi.org/10.1177%2F1049731505283698

Gelissen, J. P. T. M. (Ed.) (2010). *Qualitative research methods: Readings on collection, analysis and critiques*. Sage Publications.

Gibbs, G. R. (2007). Thematic coding and categorizing. *Analyzing Qualitative Data*, *703*, 38-56. https://dx.doi.org/10.4135/9781526441867.n4

Gil, D. G. (2013). Violence against children. Harvard University Press. https://doi.org/10.4159/harvard.9780674187917

Guedes, A., Bott, S., Garcia-Moreno, C., & Colombini, M. (2016). Bridging the gaps: a global review of intersections of violence against women and violence against children. *Global Health Action*, *9*(1), 31516. https://doi.org/10.3402/gha.v9.31516

Hahn, R., Fuqua-Whitley, D., Wethington, H., Lowy, J., Crosby, A., Fullilove, M., ... & Task Force on Community Preventive Services. (2007). Effectiveness of universal school-based programs to prevent violent and aggressive behavior: A systematic review. *American Journal of Preventive Medicine, 33*(2), S114-S129. https://doi.org/10.1016/j.amepre.2007.04.012

Hennink, M., Hutter, I., & Bailey, A. (2020). *Qualitative research methods*. Sage. https://research.tilburguniversity.edu/en/publications/3566d9d2-0f7c-45f5-9ace-ef0a272c5eb9

Hestermann, T. (2016). "Violence against children sells very well". Reporting Crime in the Media and Attitudes to Punishment". In *Women and children as victims and offenders: Background, prevention, reintegration* (pp. 923-947). Springer. http://dx.doi.org/10.1007/978-3-319-08398-8_33

Hillis, S. D., Mercy, J. A., & Saul, J. R. (2017). The enduring impact of violence against children. *Psychology, Health & Medicine*, *22*(4), 393-405. https://doi.org/10.1080/13548506.2016.1153679

Hillis, S., Mercy, J., Amobi, A., & Kress, H. (2016). Global prevalence of past-year violence against children: A systematic review and minimum estimates. *Pediatrics*, *137*(3). https://doi.org/10.1542/peds.2015-4079

Hillis, S., Mercy, J., Saul, J., Gleckel, J., Abad, N., & Kress, H. (2016). THRIVES: Using the best evidence to prevent violence against children. *Journal of Public Health Policy*, *37*(1), 51-65. https://doi.org/10.1057/s41271-016-0003-6

Holt, S., Buckley, H., & Whelan, S. (2008). The impact of exposure to domestic violence on children and young people: A review of the literature. *Child Abuse & Neglect*, *32*(8), 797-810. https://doi.org/10.1016/j.chiabu.2008.02.004

Howe, D. (2007). Child abuse: Towards a knowledge base (3rd Ed). Open University Press, 2006. 300pp. https://doi.org/10.1002/car.998

Izaguirre, A., & Calvete, E. (2017). Exposure to family violence as a predictor of dating violence and child-to-parent aggression in Spanish adolescents. *Youth & Society*, *49*(3), 393-412. https://doi.org/10.1177/0044118X16632138

Jones, L., Bellis, M. A., Wood, S., Hughes, K., McCoy, E., Eckley, L., ... & Officer, A. (2012). Prevalence and risk of violence against children with disabilities: A systematic review and meta-analysis of observational studies. *The Lancet*, *380*(9845), 899-907. https://doi.org/10.1016/S0140-6736(12)60692-8

Kardefelt-Winther, D., & Maternowska, C. (2020). Addressing violence against children online and offline. *Nature Human Behaviour*, *4*(3), 227-230. https://doi.org/10.1038/s41562-019-0791-3

Kenny, M. C. (2001). Child abuse reporting: Teachers' perceived deterrents. *Child Abuse & Neglect*, *25*(1), 81-92. https://doi.org/10.1016/S0145-2134(00)00218-0

Kitzinger, J. (2004). *Framing abuse* (Vol. 7). Pluto Press. https://doi.org/10.2307/j.ctt18mbdqw

Kramsch, C. (2013). Culture in foreign language teaching. *Iranian Journal of Language Teaching Research*, *1*(1), 57-78.

Kramsch, C., & Thorne, S. L. (2002). *Foreign Language Learning as Global Communicative Practice* (pp. 93-110). Routledge.

Krug, E. G., Mercy, J. A., Dahlberg, L. L., & Zwi, A. B. (2002). The world report on violence and health. *The Lancet, 360*(9339), 1083-1088.

Kula, S. S., & Akbulut, O. F. (2021). Determination of pre-service teachers' sensitivity to violence against children. *Eurasian Journal of Educational Research*, *92*, 185-209. http://dx.doi.org/10.14689/ejer.2021.92.10

Low, S. K., Kok, J. K., & Lee, M. N. (2013). A holistic approach to school-based counselling and guidance services in Malaysia. *School Psychology International*, *34*(2), 190-201. https://doi.org/10.1177%2F0143034312453398

McCoy, A., Melendez-Torres, G. J., & Gardner, F. (2020). Parenting interventions to prevent violence against children in low-and middle-income countries in East and Southeast Asia: A Systematic Review and Multi-Level Meta-Analysis. *Child Abuse & Neglect*, *103*, 104444. https://doi.org/10.1016/j.chiabu.2020.104444

McKee, B. E., & Dillenburger, K. (2012). Effectiveness of child protection training for pre-service early childhood educators. *International Journal of Educational Research*, *53*, 348-359. https://doi.org/10.1016/j.ijer.2012.04.008

McLeigh, J. D., & Taylor, D. (2020). The role of religious institutions in preventing, eradicating, and mitigating violence against children. *Child Abuse & Neglect*, *110*, 104313. https://doi.org/10.1016/j.chiabu.2019.104313

Nagle, J. (2018). Twitter, cyber-violence, and the need for a critical social media literacy in teacher education: A review of the literature. *Teaching and Teacher Education*, *76*, 86-94. https://doi.org/10.1016/j.tate.2018.08.014

Nkuba, M., Hermenau, K., Goessmann, K., & Hecker, T. (2018). Reducing violence by teachers using the preventative intervention interaction competencies with children for teachers (ICC-T): A cluster randomized controlled trial at public secondary schools in Tanzania. *Plos One*, *13*(8), e0201362. https://doi.org/10.1186/s13063-018-2827-9

Öztürk, A. B. (2009). Çocuğun cinsel istismarı ve aileyle çalışma [Child sexual abuse and working with the family]. *Toplum ve Sosyal Hizmet*, *20*(2), 89-98.

Patton, M. Q. (2014). *Qualitative research & evaluation methods: Integrating theory and practice*. Sage publications. https://doi.org/10.1002/0470013192.bsa514

Pereznieto, P., Montes, A., Routier, S., & Langston, L. (2014). *The costs and economic impact of violence against children*. ChildFund.

Peterson, J., & Densley, J. (2017). Cyber Violence: What do we know and where do we go from here? *Aggression And Violent Behavior*, *34*, 193-200. https://doi.org/10.1016/j.avb.2017.01.012

Pianta, R. C., Hamre, B., & Stuhlman, M. (2003). Relationships between teachers and children. In W. M. Reynolds & G. E. Miller (Eds.), *Handbook of psychology: Educational psychology* (Vol. 7, pp. 199–234). John Wiley & Sons.

Polat, O. (2014). Klinik Adli Tıp, 7. Baskı, Seçkin yayınları, pp.112-117 [Clinical Forensics (7th Edition)]. Distinguished publications.

Rasmussen, E. E. (2014). Proactive vs. retroactive mediation: Effects of mediation's timing on children's reactions to popular cartoon violence. *Human Communication Research*, *40*(3), 396-413. https://doi.org/10.1111/hcre.12030

Risager, K. (2007). *Language and culture pedagogy*. Multilingual Matters. https://doi.org/10.21832/9781853599613

Roorda, D. L., Koomen, H. M., Spilt, J. L., & Oort, F. J. (2011). The influence of affective teacher–student relationships on students' school engagement and achievement: A meta-analytic approach. *Review of Educational Research*, *81*(4), 493-529. https://doi.org/10.3102%2F0034654311421793

Rubenstein, B. L., & Stark, L. (2017). The impact of humanitarian emergencies on the prevalence of violence against children: An evidence-based ecological framework. *Psychology, Health & Medicine*, *22*(sup1), 58-66. https://doi.org/10.1080/13548506.2016.1271949

Sabol, W. J., Coulton, C. J., & Korbin, J. E. (2004). Building community capacity for violence prevention. *Journal of Interpersonal Violence*, *19*(3), 322-340. https://doi.org/10.1177%2F0886260503261155

Schalkwyk, G. J. V., & Sit, H. H. (2013). Evaluating school-based psychological and counselling services in Macao using a qualitative approach. *School Psychology International*, *34*(2), 154-165. https://doi.org/10.1177%2F0143034312453395

Seddighi, H., Salmani, I., Javadi, M. H., & Seddighi, S. (2021). Child abuse in natural disasters and conflicts: A systematic review. *Trauma, Violence, & Abuse*, *22*(1), 176-185. https://doi.org/10.1177%2F1524838019835973

Sercu, L. (2005). *Foreign language teachers and intercultural competence*. Multilingual Matters. https://doi.org/10.21832/9781853598456

Silver, R. B., Measelle, J. R., Armstrong, J. M., & Essex, M. J. (2005). Trajectories of classroom externalizing behavior: Contributions of child characteristics, family characteristics, and the teacher–child relationship during the school transition. *Journal of School Psychology*, *43*(1), 39-60. https://doi.org/10.1016/j.jsp.2004.11.003

Smith, D. L., & Smith, B. J. (2006). Perceptions of violence: The views of teachers who left urban schools. *The High School Journal*, *89*(3), 34-42. http://www.jstor.org/stable/40364231

Thanasoulas, D. (2001). The importance of teaching culture in the foreign language classroom. *Radical Pedagogy*, *3*(3), 1-25.

Thomas, G. (2021). *How to do your case study*. Sage.

Thoresen, S., Myhre, M., Wentzel-Larsen, T., Aakvaag, H. F., & Hjemdal, O. K. (2015). Violence against children, later victimisation, and mental health: A cross-sectional study of the general Norwegian population. *European Journal of Psychotraumatology*, *6*(1), 26259. https://doi.org/10.3402/ejpt.v6.26259

Tourigny, M., Hébert, M., Joly, J., Cyr, M., & Baril, K. (2008). Prevalence and co-occurrence of violence against children in the Quebec population. *Australian and New Zealand Journal of Public Health*, *32*(4), 331-335. https://doi.org/10.1111/j.1753-6405.2008.00250.x

Unicef. (2009). *The State of the World's Children-Special Edition: Celebrating 20 Years on the Convention on the Rights of the Child: Executive Summary*. UNICEF.

Walker-Descartes, I., Hopgood, G., Condado, L. V., & Legano, L. (2021). Sexual violence against children. *Pediatric Clinics*, *68*(2), 427-436. https://doi.org/10.1016/j.pcl.2020.12.006

Walsh, K., Bridgstock, R., Farrell, A., Rassafiani, M., & Schweitzer, R. (2008). Case, teacher and school characteristics influencing teachers' detection and reporting of child physical abuse and neglect: Results from an Australian survey. *Child Abuse & Neglect*, *32*(10), 983-993. https://doi.org/10.1016/j.chiabu.2008.03.002

Waterston, T., & Mok, J. (2008). Violence against children: the UN report. *Archives of Disease in Childhood*, *93*(1), 85-88. http://dx.doi.org/10.1136/adc.2006.113340

Whitzman, C. (2012). *The handbook of community safety gender and violence prevention: Practical planning tools*. Routledge. https://doi.org/10.4324/9781849773058

Wilson, S. J., Tanner-Smith, E. E., Lipsey, M. W., Steinka-Fry, K., & Morrison, J. (2011). Dropout prevention and intervention programs: Effects on school completion and dropout among school-aged children and youth. *Campbell Systematic Reviews*, *7*(1), 1-61.

World Health Organization (2002). World report on violence and health. Retrieved from: https://apps.who.int/iris/bitstream/handle/10665/42495/9241545615_eng.pdf;jsessionid=3072286457F595755E97FA5D5A6DEA54?sequence=1

World Health Organization (2011). *World report on violence*. http://www.who.int/topics/violence/en/

World Health Organization. (2019). *INSPIRE handbook: Action for implementing the seven strategies for ending violence against children*. World Health Organization.

Wright, R. J. (2011). *Introduction to school counseling*. Sage Publications.

Yazan, B. (2015). Three approaches to case study methods in education: Yin, Merriam, and Stake. *The Qualitative Report*, *20*(2), 134-152.

Received: *November 29, 2021* Accepted: *February 10, 2022*

Cite as: Celik, B., Yildiz, Y., & Bilgin, R. (2022). Perceptions and recommendations of foreign language teachers to prevent children violence and abuse: A case study in Tishk international university students in Erbil, Iraq. *Problems of Education in the 21st Century*, *80*(1), 82-118. https://doi.org/10.33225/pec/22.80.82

Bunyamin Celik *(Corresponding author)*	PhD, Lecturer, Department of Languages, Tishk International University, Erbil, Iraq. E-mail: bunyamin.celik@tiu.edu.iq ORCID: https://orcid.org/0000-0002-1595-7273
Yunus Yildiz	PhD, Lecturer, Department of Languages, Tishk International University, Erbil, Iraq. E-mail: yunus.yildiz@tiu.edu.iq ORCID: https://orcid.org/0000-0002-4471-457X
Recep Bilgin	Assistant Lecturer, Department of Languages, Tishk International University, Erbil, Iraq. E-mail: recep.bilgin@tiu.edu.iq Website: https://staff.tiu.edu.iq/academic-staff/receb-bilgin/

This is an open access article under the
**Creative Commons Attribution 4.0
International License**

INTEGRATION OF ENVIRONMENTAL EDUCATION (EE) IN TEACHER EDUCATION PROGRAMS: TOWARD SUSTAINABLE CURRICULUM GREENING

Alma M. Corpuz
Tarlac State University, Philippines
E-mail: almamarcelinocorpuz@gmail.com

Teody C. San Andres
Bulacan State University, Philippines
E-mail: teodysanandres.evp@bulsu.edu.ph

Julieta M. Lagasca
Tarlac State University, Philippines
E-mail: jd_102885@yahoo.com

Abstract

Environmental education (EE) is vital in addressing global environmental problems. Educational institutions are integrating EE into their curricula, but studies indicated the need for its intensification. This mixed method study assessed the integration of EE in Teacher Education Programs (TEPs) in Region III, Philippines. Respondents were 10 program deans,10 chairs, 171 teachers, and 344 students. Data were gathered using validated questionnaires. Findings revealed that the New Teacher Education Curriculum (NTEC) integrated EE in program outcomes and performance indicators; in mandated courses -Physical Education (PE) and National Service Training Program (NSTP); and in Science Technology and Society (STS), a General Education (GE) course. Likewise, teachers integrated EE in their lessons and in community extension programs. Seminars/webinars included environmental care and promoted environmental awareness in social media. As to support for EE integration, administrative, physical facilities and financial support were provided. On student outcomes, positive findings were shown on attitude towards environment care, but application of knowledge and skills needs improvement. Students' knowledge was significantly correlated to attitude (Pearson's r value is.593 and p value <.05) as well as skills acquisition and attitude (Pearson's r value is .647 and p value <.05). Teachers' challenges in the EE integration included inadequate environmental knowledge and lack of time to lead students in environmental action. The study concludes that EE is integrated into the TEPs but the outcomes on the learners' knowledge and skills acquisition still need strengthening. Also, EE should be integrated in professional education courses, not only in GE and mandated courses.

Keywords: *assessment, integration of environmental education, mixed method, sustainable curriculum greening, teacher education programs*

Introduction

Climate change (CC) continues to threaten the world (United Nations, 2020) and the environmental effects are occurring earlier than predictions. These include shrinking glaciers, accelerated rising of sea level, more intensified heatwaves, and shifting of plants and animals (Global Climate Change, 2021). The environmental changes affected the globe. Even USA, the most powerful country, is bombarded with environmental problems which include

ISSN 1822-7864 (Print) ISSN 2538-7111 (Online) https://doi.org/10.33225/pec/22.80.119

deforestation; air pollution; global warming due to melting ice glaciers; intense hurricanes and water pollution due to sewerage getting into water pipes; and chemical contamination of water bodies from pesticides, and natural resource depletion (Tsui, 2020). Likewise, in Southeast Asia, six environmental issues include endangered species conservation, air pollution, destruction of coral reefs, deforestation, water security, and increased urbanization (Hershberger, 2014).

Taking environmental issues into the equation, the United Nations had developed 17 Sustainable Development Goals (SDGs). Goals that directly affect environmental issues are SDG6 (clean water); SDG7 (clean energy); SDG 12 (responsible consumption); SDG 13 (Climate Action); SDG 14 (life underwater); and SDG 15 (life on land). UN targets the realization of these goals by 2030 (SDG, 2020). To realize the SDGs targeting environment development, government leaders across countries in the world need to find more effective mitigating measures. However, while government leaders are to be the CC czars, the Commonwealth of Education Hub (2020) asserts a multisectoral approach to respond to this global issue. This is supported by the DENR secretary of the Philippines who stated that "the realization of the SDGs relative to environmental issues and problems, is not the sole responsibility of the government but of all individuals."

One of the sectors seen as potential platforms of environmental action (EA), is education. Schools are strategic avenues in the development of students' attitude and help them become CC active advocates through increased climate literacy and CC-related trends (United Nations Educational, Scientific, and Cultural Organization, n.d.). Environmental education in curricular programs enables youth engagement in green growth (Climate Change Commission, 2011); development of informed decision-making skills; active environmental involvement as influencers; and in adaptation of sustainable lifestyles (UNESCO, n.d.). Teaching CC and helping students understand it, is no longer just an interest of scientists. So, teachers must integrate elements of CC into their instructional plans to enable student knowledge on how they can participate in addressing CC problems to their capacity level. Students must understand that CC has consequences for the earth and human lives, and they have vital role to play to address the negative effects.

The features of EE include EA and mindfulness; environmental knowledge and learning; positive attitudes; skills; participation; and promotion of green facilities (Conserve Energy Future, n.d.). These features hope to allow individuals to explore environmental issues, engage in problem solving, and take action to improve the environment. Moreover, EE would result in individuals having deeper understanding of environmental issues; possessing skills to make informed decisions; and becoming responsible for their actions (EPA, 2018). Integration of EE in educational curricula will potentially lead to the youths' acquisition of knowledge, skills and attitude that will make them vital agents of environmental protection.

Countries abroad like India (Verma & Dhull, 2017), Tanzania, (Mwendwa, 2017), and Botswana (Velimpini, 2016) have integrated EE into various sectoral and educational curricula. In the Philippines, EE is also integrated in various institutions, especially in education. However, literature and studies reviewed showed the need to strengthen EE programs (Department of Education, 2020), conduct assessment of integration outcomes, identify issues in the integration (Marpa, 2020), and determine if integration attempts are effective and sustainable (Perez & Bua, Jr., 2019).

Additionally, Labog (2018) determined the correlation between teachers' integration of EA and level of sustainable development practices of selected public high schools in a district of Oriental Mindoro. The study findings revealed that teachers integrate EA topics on waste management, forest conservation and climate change in their class lessons. Teachers had enabled student acquisition of knowledge and understanding of global environmental issues and students, but more involvement is needed to become responsible environmental and sustainable citizens. Garcesa and Limjuco (2016) also determined the relationship between the level of environmental literacy and level of integration of environmental issues of Science teachers in Region XI. The study found that Science teachers had high level of overall environmental literacy and integration of environmental issues. A significant correlation was found between environmental literacy and level of integration of environmental issues. This indicates widespread environmental literacy in the school for better outcomes on environment action.

The studies of Labog (2018) and Garccesa and Limjuco (2016) affirmed the integration of environmental issues in high school education curriculum but both studies did not explore the outcomes of such integration on the learners. The present study investigated the outcomes of the IEE in the NTEC in terms of knowledge and skills acquisition and development of positive attitude towards environmental action. Similarly, Abun and Racoma (2017) also analyzed the environmental attitude of employees of a school in Ilocos. The findings revealed that the employees generally had ambivalent environmental attitudes which were affected by lack of understanding about environmental ethics. The study then recommended the need to improve the awareness or understanding about natural environment through seminars on environment and environmental ethics in the curriculum.

Moreover, the Commission on Higher Education (CHED) and Department of Education (DepED have crafted policies, guidelines, programs, projects, and activities which support the integration of climate change adaptation and mitigation and environmental education through CHED Memorandum (CMO)No. 33, series of 2009, CMO No. 52, s of 2016, and DepED Order No. 33 s. 2011. The initiatives are seen in research priority programs, curricular enhancements, and extension activities. CHED (2012) cited the research of Eileen Bernardo of Isabela State University on curriculum enhancement and biodiversity emphasizing that HE plays a critical role in preparing/providing the leadership to meet challenges in these areas; HEIs are well placed to contribute to the process; and HEIs can make meaningful contribution in providing solutions to the challenges posed by CC and biodiversity loss. However, the study concluded that educational initiatives related to CC lacked coordination and cooperation among HEIs. Accordingly, there are still many structural obstacles for a real integration in curricula and daily classroom work.

Further measures to promote climate change and EA pursuant to Republic Act (R.A.) No. 9512, “An Act to Promote Environmental Education and for Other Purposes” were DO No. 52, series of 2011, “Strengthening Environmental Education in Public and Private Schools;” DO No. 93, series of 2011, “Mandates Programs, Projects and Activities under the Youth for Environment in Schools Program;” and Department Memorandum No. 019, series of 2018 or the “Activities of the DENR,” (DepEd, 2011, 2018; Environmental Management Bureau, n.d.). The DepED also included “makakalikasan” (pro-environment) in the core values statement (DepED, n.d.).

However, Perez and Bua, Jr. (2019) concluded in their study that the concept of sustainable development is not yet in the current K to 12 curriculum and all standards based on DepED Order No. 08, series of 2015 were only “moderately” achieved by secondary schools. The researchers concluded that sustainability of environmental projects is unclear and the inadequate resources to support integration programs served as hindrances. Other problems identified were mobility of various resources managed by the residents and continuation of projects due to shifting interest of community leaders and sources of funds. The researchers recommended the inclusion of EE in co-curricular projects as researchers took notice of the growing interest in EE among the members of the community and the possible cooperation of agencies as potential opportunities for improved IEE secondary school level.

Hence, the researchers deemed it necessary to assess the integration of EE in school curricula. Findings are necessary to strengthen the role of education in addressing environmental issues and problems. Curriculum developers, which include school heads, teachers and stakeholders must have thorough grasp of their role in the integration of EE into educational curricula so they can effectively bridge the gap that hinders youth environmental empowerment. Strategic integration of EE in daily classroom activities would effectively fulfill the role of education in environment awareness and action.

The present study determined and analyzed the integration of EE in the New Teacher Education Curriculum (NTEC) in Region III State Universities and Colleges (SUCs). The researchers believe that equipping teachers as environmental advocates should start in their training stage. So, EE should be effectively ingrained in the curriculum.

Research Problem

Clearly, the role of education is vital in raising the environmental awareness of students and in motivating them to take part in programs launched to mitigate environmental problems. However, while the efforts to integrate EE into various curricular programs are apparent, cited literature and studies suggest the need to further strengthen programs to attain success. For example, DepEd recently launched the "Search for Sustainable Eco-Friendly Schools," in partnership with the DENR, Environmental Management Bureau (EMB) and the CHED (Malipot, 2019). This program hopes to address the need to increase climate change awareness and environmental consciousness of students. In addition, support to teachers' integration of climate change in the curriculum was heightened through the availability of curated resources for teaching climate change for School Year 2020-2021 (DepED, 2021). The learning materials will lessen the burden of teachers to develop environmental awareness learning resources for their students.

This study then aimed to assess the integration of EE in TEPs in the SUCs of Region III, Philippines in terms of the strategies, outcomes and challenges encountered. Findings led to the development of enhancement measures that TEPs may implement to equip and empower students to take care of the environment.

Research Focus

The present study analyzed how the SUCs in Region III, Philippines integrated environmental education into the NTEC. The contents of the latest CMOs governing the offering of BEEd and BSEd programs were analyzed in terms of specific provisions related to environmental education; policies, guidelines, and programs for the integration of EE; and classroom teaching-learning activities that integrate EE. Moreover, outcomes of the EE integration on students' knowledge, skills, and attitude were determined. Currently, integration of EE in the New Teacher Education Curriculum and have not been explored in as well as the outcomes of the IEE on the students' knowledge, skills, and attitude. The findings of the study were inputs to the development of proposed measures to deepen the integration of EE into the BSEd and BEEd programs for sustainable curricular greening.

Research Aim and Research Questions

The study aimed to assess the integration of EE in the NTEC among SUCs in Region III, Philippines. The following questions were answered:

1. How is EE integrated in the NTEC?
2. What are the outcomes of integration of EE among the students in terms of environmental knowledge, skills, and attitude?
3. Is there a significant correlation between knowledge and skills outcomes and attitude of the students?

4. What is the school management support provided in the integration of EE in the NTEC?
5. What are the challenges in the integration of EE in NTEC?
6. What enhancements could be proposed in NTEC for IEE for sustainable curriculum greening?

Hypothesis

There is no significant correlation between knowledge and skills outcomes and attitude of the students.

Research Methodology

General Background

The study assessed the strategies of the TEPs in the integration of EE (curriculum greening) into NTECs among SUCs in Region III, Philippines. A mixed quantitative and qualitative design was employed in data gathering and analysis. Quantitative data were gathered using closed-ended questionnaires. Qualitative data were gathered through open-ended questionnaires and documents relative to curricular contents and provisions. The study was conducted in Academic Calendar Year 2020-2021.

Sample

Deans, teachers, and students of the Region III SUCs in the Philippines offering Teacher Education Programs were included as respondents of the study. The Yamane formula was used to compute the sample sizes needed to represent the teachers and students (Statistics How To, 2021). The sample size for teachers is 171 out of 316 total population and 344 for students out of 2,450 total population based on the deans' estimates. On the other hand, complete enumeration technique was used in considering the second set of respondents who comprised 10 deans and 10 chairs from the 10 TEIs of Region III SUCs.

Instrument and Procedures

Three sets of close-ended questionnaires were developed, validated, and transported to Google forms to gather data from the three sets of respondents. Open-ended questions were added to the questionnaire for the deans and chairpersons. In addition, the NTEC CMO documents and the curricular content offerings of the TEPs were obtained from the schools and were subjected to documentary analysis.

The three sets of questionnaires were validated by experts. The questionnaire for the deans and chairpersons (4.48) and teachers (4.45) got very satisfactory ratings from the experts. On the other hand, questionnaire for students had an excellent rating (4.57). Some experts had suggestions to improve the questionnaire and were considered in the final questionnaire transported to Google Forms for dry run. Data from the dry run were analyzed to establish reliability and validity. The questionnaire for teachers and deans and chairpersons got 0.96 Index of Reliability and 0.94 for the questionnaire intended for students. Both values indicate reliable and valid research tools.

After validation, the questionnaires were exported to Google Form for fast data gathering. The researchers sought help from the deans and chairpersons to share the link or URL to teachers and students. One-hundred percent response from the deans and chairpersons

https://doi.org/10.33225/pec/22.80.119

was obtained within three days. For the teachers, 100% response (171) was completed within a week and two weeks completion for students (344). Data from excel were downloaded and subjected to statistical analysis.

Research ethics was observed in conducting the study. The data gathered via Google Forms were carefully handled and the provisions of the Data Privacy Act of 2012 were observed by the researchers. Data extracted from the Google Forms were only accessed by the researchers and the statistician. The identities of the respondents were kept confidential. Moreover, the protocol was subjected for ethics review by the TSU-Research Ethics Review Committee. The research was given an ethical clearance certificate.

Data Analysis

After two weeks of online data gathering, the summarized data from excel was downloaded and subjected to statistical analysis using frequency, mean and Pearson Product-Moment Correlation Coefficient (Pearson's r). For qualitative data, mixed documents-based analysis technique and narrative analysis from open-ended questionnaires were employed. Carter et al. (2018) suggested the use of corroboration when dealing with qualitative data. Documents should be triangulated with interview and observation. In this study, curricular programs (prospectus) were requested to examine where EE was integrated. The course syllabi used by teachers were also requested to corroborate the responses in the open-ended questions.

Research Results

Strategies in the Integration of Environment Education (EE) in Teacher Education Programs

The analysis of the integration of EE in New Teacher Education Curricula (NTEC) was based on examining the CMO Nos. 74, and 75 series of 2017 (BEEd and BSEd, respectively); policies, guidelines, and programs; and in the teaching-learning process.

Integration of EE in the Curricular Contents

Integration of environmental education in the CMOs for BEEd and BSEd offered by the SUCs was analyzed. The strategies used in integrating environmental education in the NTEC were extracted from open-ended questions answered by the deans and chairpersons and by analyzing documents, which included the CMO No. 74, series of 2017 for Bachelor of Elementary Education (BEEd) and CMO No. 75, series of 2017, for Bachelor of Secondary Education (BSEd). The integration of EE in both programs was examined in statement of program outcomes, program indicators, and the curricular content (General Education Courses, Professional Education Courses Major/Specialization Courses and Mandated Courses). Copies of the two CMOs were downloaded from the CHED website and sample curricular contents were requested from two schools through the chairpersons.

Based on the data gathered, EE is integrated in the mandated courses NSTP and PE (all SUCs) and Environmental Science under the GE courses (for some SUCs). According to the interview with CP1a, in Physical Education, personal health, and community development included topics on EA. In NSTP, CP3 claimed that EA and action are integrated. During the face-to-face classes, activities of NSTP included tree planting and clean-up drive. However, these activities were suspended due to COVID-19 pandemic. Instead, webinars related to EA were attended by teachers and students. In addition, STS is a GE course included in the BEEd curriculum in all SUCs and in the CHED recommended Outcomes Based Teaching and

Learning (OBTL) for STS included topics on EA and CC. For BEEd program, EE is integrated mostly in GE and mandated courses.

As to the BSEd program, EE is also integrated in the General courses (STS) and mandated courses (PE and NSTP). But unlike the BEEd program, CMO No. 75, s of 2017 for the BSEd program clearly included statements about EE in program outcomes and performance indicators. For example, in BSEd in Social Studies, program outcomes were explicitly stated: (1) "To employ the principles of sustainable development in teaching and learning process" and the performance indicator is "Initiate advocacy campaigns towards the attainment of sustainable goals," "Organize initiatives for stewardships of natural resources," "Participate in activities that promote, and Integrate the environmental principles in teaching and learning."

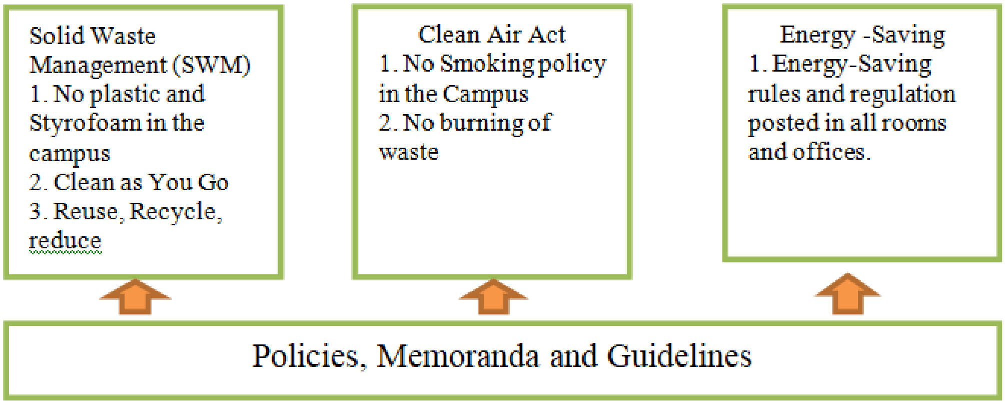
Another evidence of EE integration is in the major courses of BSEd in Social Studies - Human Geography, Physical Geography and Urban Geography. According to CP1b, the faculty member handling the course, they sponsored programs that promoted environmental awareness and action. Examples of the activities conducted were campaign against plastic use and Styrofoam; planting of trees and ornamental plants; and recycling waste to make decorations and bags. Summary of the integration of EE in the CMOs is shown in Appendix A.

Findings showed that in both BEEd and BSEd programs, EE was integrated in GE and mandated courses but not in professional and in major courses.

Integration of EE through Policies and Memoranda and Guidelines

Policies, memoranda, and guidelines to integrate EE in TEPs were also examined in this study and the results are reflected in Figure 1.

Figure 1
Policies, Programs and Guidelines Integrating EE in the TEPs


Solid Waste Management (SWM)
1. No plastic and Styrofoam in the campus
2. Clean as You Go
3. Reuse, Recycle, reduce
Clean Air Act
1. No Smoking policy in the Campus
2. No burning of waste
Energy -Saving
1. Energy-Saving rules and regulation posted in all rooms and offices.
Policies, Memoranda and Guidelines

The policies, guidelines, and programs implemented in the SUCs were extracted from the open-ended questions for deans and chairpersons. The data from the respondents were grouped into three categories. The first category of EE programs is solid waste management. For this category, at least three were common among the SUCs. These were based on the response of all the deans and chairs (20 or 100%). The first is *"No Plastic and Styrofoam in the Campus."* All employees, students, visitors, and other individuals are not allowed to bring in plastics or Styrofoam in all campuses. Canteen operators were also required to abide by the non-use of plastics, Styrofoam, and straws. Another program implemented in all schools is *"Clean as You Go."* In this program, students and other school stakeholders are expected to maintain cleanliness in school campuses. Additionally, labeled waste receptacles are in strategic areas in the school campuses in conformance to the proper waste segregation guideline of RA 9003, or the Ecological Solid Waste Management Program. Part of the SWMP is the practice of *"reuse, recycle and reduce."* All personnel and students were regularly encouraged to properly throw waste in designated bins to help the housekeeping personnel in waste segregation and disposal.

The second category of programs to support IEE is the "Clean Air Act of 1999." Here, schools imposed the *"No Smoking Policy"* and the *"no burning of waste"* guideline of the RA 9003. Signages were strategically posted near the entrance gates to ensure that the policies are known by everyone entering the school. Aside from entrance, signages were also posted in school buildings, classrooms, comfort rooms, and other strategic areas within the school campuses.

Lastly, schools practiced energy saving measures. Air conditioning units were only switched on at 9 A.M. and put off at 4:00 P.M. in offices and classrooms. Reminders to put off lights and other equipment when not in use were posted in all offices, classrooms, and other function rooms.

Table 1
Teachers' Strategies in Integrating EE in Teaching-Learning Process

Strategies	Mean	Standard Deviation	Verbal Description
Open sharing in class on the effects of CC and how each can contribute to prevent future devastations due to man-made activities.	4.1	0.95	Often
Starting class sessions by sharing the need to perform roles in taking care of the environment, such as following rules on waste management inside the class, at home and wherever students are.	3.81	0.97	Often
Encouraging students to participate in community activities that promote environmental care and awareness.	3.78	1.01	Often
Encouraging students to attend seminars, workshops and training relative to environmental care and awareness.	3.54	1.05	Often
Participating in school-wide activities related to environmental awareness.	3.56	1.08	Often
Integrating solid waste management (recycle, reuse, reduce and waste segregation) in classroom.	3.49	0.96	Sometimes
Including questions about current CC issues in assessments.	3.46	1.05	Sometimes
Requiring news readings about current environmental problems.	3.46	0.99	Sometimes
Integrating environment care and CC mitigation in syllabus.	3.38	1.19	Sometimes
Requiring research activities on environment and CC.	2.06	1.16	Rare

Whenever devastating calamity strikes, teachers spared a time to talk about the calamity in class before proceeding to the lesson discussions (4.10). Teachers shared about the effects of climate change and challenged students to do their part in lessening activities that add to environment pollution and CC devastations. In addition, teachers often started class by challenging students to perform their roles in caring for the environment. Teachers reminded students to abide by solid waste management policies in school, at home, and in their communities (4.03). Teachers often reminded students to throw their waste properly in designated trash bins to facilitate waste segregation.

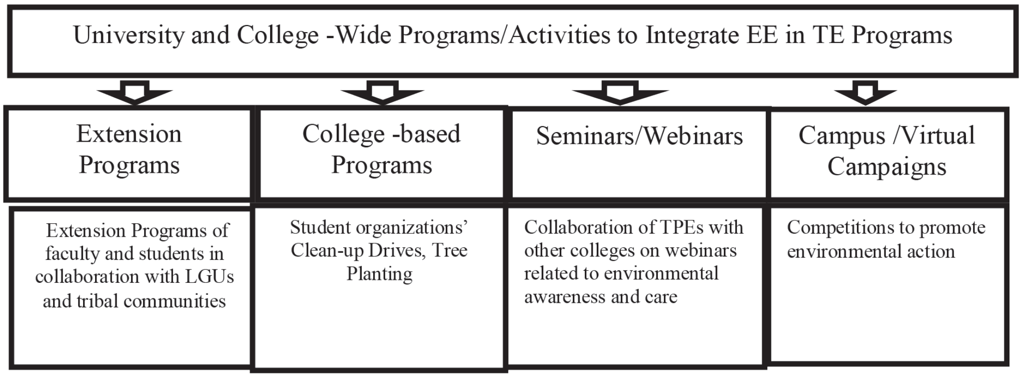
Moreover, teachers encouraged students to participate in school or community activities that promote environmental care and awareness like tree planting, clean up drive and others (3.56). Activities on environmental care were usually initiated in the NSTP; so, all students had experienced planting trees and clean-up drives. Teachers also encouraged students to attend seminars, workshops, and trainings relative to environmental care and awareness (3.54). In the past, students in TEPs joined seminars related to environmental awareness and care sponsored by other colleges but in the new normal, activities were more on webinars. In one of the SUCs, teacher CP2, shared that student organizations were active in joining webinars related to environmental awareness and care. Teacher CP2 related that the student organization members were active in joining the environment programs of the LGU where their school is located.

Another strategy was to encourage students to attend seminars, workshops, and trainings relative to environmental awareness and care (3.80) and participate in school-wide environment-related activities (3.80). Planting trees and other ornamental plants in school campuses and in communities was a common activity in all SUCs.

University or College- Wide Programs that Integrate EE

The deans and chairs were provided with open-ended questionnaire to ask about the programs or activities that they implemented in their respective colleges to support the integration of EE. The themes generated based on the data are shown in Figure 2.

Figure 2
The University or College - Wide Programs that Integrate EE


University and College -Wide Programs/Activities to Integrate EE in TE Programs
Extension Programs
College -based Programs
Seminars/Webinars
Campus /Virtual Campaigns
Extension Programs of faculty and students in collaboration with LGUs and tribal communities
Student organizations' Clean-up Drives, Tree Planting
Collaboration of TPEs with other colleges on webinars related to environmental awareness and care
Competitions to promote environmental action

Extension programs of the SUCs included environmental care in their adopted communities. Usually, TEPs entered into Memorandum of Agreement (MOA) with the communities to conduct extension programs, which include EE. Examples of extension programs were providing seedlings to the adopted community members for backyard or pot gardening; environment education seminars; and organic farming. In addition, joint competitions to raise environmental awareness and action were also launched in all SUCs. In Bulacan State University, a Mangrove Project was part of their extension program in a community. The school was involved in coastal rehabilitation in cooperation with Wetlands International Philippines.

Support from the Management on the Integration of EE in TE Programs

The support of the management in IEE in teaching-learning process was determined based on the perception of the teachers and the data are shown in Table 2.

On the administrative support, teachers claimed that extension efforts (4.31) and research opportunities were promoted and supported (4.28). Trainings and seminars to enhance teachers' knowledge competence were provided and were opened to the teachers and students (4.16). During the pandemic, webinars were available and shared to all interested teachers and students. Moreover, release of Memoranda relative to the implementation of the new TEI curriculum, with emphasis to the promotion of environmental awareness was prompt and cascaded clearly to teachers (4.02). All memoranda from the management of most SUCs were posted in Facebook through the respective Public Affairs offices. However, incentives for exemplary accomplishments of targets relative to promotion of environmental awareness and climate change were fairly awarded since this was not consistently observed (2.90).

Table 2
Support in the Integration of EE in the Teaching -Learning Process

IEE Support	Mean	Standard Deviation	Verbal Description
A. Administrative Support			
Administrators support extension promoting environmental awareness (EA) and climate change (CC).	4.31	0.66	Often
Support to research opportunities promoting EA and CC.	4.28	0.67	Often
Support to trainings and seminars promoting EA and CC.	4.16	0.76	Often
Prompt release of memoranda relative to the implementation of the new TEI curriculum, with emphasis to EA and CC and cascading to teachers.	4.02	0.77	Often
Incentives to exemplary accomplishments of targets to promote EA and CC.	3.78	0.83	Sometimes
B. Physical/Material Support			
Available and accessible vehicles for off-campus activities.	4.07	0.88	Often
Provision of Facilities and materials to complete extension activities to promote EA and CC.	4.03	0.85	Often
Provision of facilities and materials needed to complete research in promotion of EA and CC.	2.56	0.87	Often
Prompt provision of laboratory reagents and other needs for experiments related to environment research.	2.88	0.92	Sometimes
Provision of Instructional Materials/Equipment to integrate topics on environment and climate change by the management and other school stakeholders.	2.78	0.93	Sometimes
C. Financial Support			
Management and other stakeholder's financial support for extension activities in the promotion of EA and CC.	4.13	0.84	Often
Management and other stakeholder's financial support for research activities in the promotion of EA and CC.	4.10	0.66	Often
Management and other stakeholder's financial support for curricular activities in the promotion of EA and CC	2.99	0.67	Sometimes
Management and other stakeholder's financial support to acquire instructional materials in the promotion of EA and CC.	2.97	0.76	Sometimes
Management and other stakeholder's financial support for physical arrangement of classrooms in the promotion of EA and CC	2.06	0.77	Rare

On physical or material support, teachers claimed that transport vehicles for off-campus activities were often available and accessible (4.07); facilities and materials needed to complete extension activities in the promotion of EA and CC (4.03) and to complete research relative to the promotion of EA and CC were provided in school (2.56). However, laboratory reagents and other needs for experiments were sometimes promptly provided (2.88). Teachers claimed that some experiments were not performed due to lack of materials.

As to financial support, teachers claimed regular support were provided for extension activities (4.13) and research (4.10). However, financial support to carry out class/school activities for the promotion of EA and CC (2.99) including financial support to acquire Instructional Materials (IMs) for the promotion of EA and CC (2.97), and financial support to improve physical classroom arrangement that supports EA and CC mitigation (2.06) were sometimes provided.

Findings revealed that administrative support for IEE in teaching-learning process gained positive feedback from the teachers but not in material and financial support. Feedback from teachers got means equivalent to "sometimes" response which indicates the belief of teachers that management support in these areas lacked consistency.

Outcomes of Integration of EE in Teacher Education Program

The outcomes of the integration of EE in TEPs were determined based on student feedbacks. Findings shown in Table 3 revealed that students often supported the "no smoking policy" in school or other public places (4.82); turned off lights when not in use (4.79); used water wisely (4.78); unplugged power cords and powered off computers or gadgets when not in use (4.74); threw waste in designated waste bins (4.64); often contributed to minimizing energy consumption bills to conserve energy (4.49); and used fans /blowers instead of air-conditioning units (4.49). In the campuses, reminders were posted in classrooms, stairs, pathways, bulletin boards in all buildings, and other places where students mostly spend their free time.

Table 3
Outcomes /Applications of Integration of EE in Students' Knowledge Acquisition

Knowledge acquisition Outcomes	Mean	Standard Deviation	Verbal Description
Minimizing energy consumption for conservation.	4.21	0.60	Often
Using fans /blowers instead of air-conditioning units.	4.19	0.72	Often
Not burning leaves, trash, and other materials.	4.15	0.85	Often
Using public transportation or carpooling.	4.09	0.70	Often
Replacing incandescent light bulbs with compact fluorescent or LED.	4.02	0.53	Often
Purchasing energy-efficient appliances.	4.01	0.49	Often
Supporting the "no smoking policy" in school or other public places.	3.81	0.57	Often
Turning off the lights when not in use.	3.79	0.84	Often
Using water wisely at home. (e.g. conserving water)	3.61	0.82	Often
Unplugging power cords and power off computers or gadgets when not in use.	3.54	0.70	Often
Disposing off or handle hazardous waste properly.	3.35	0.78	Sometimes
Reusing, recycling, and reducing waste materials.	3.21	0.92	Sometimes
Planting trees or vegetables to contribute to greening the environment.	3.19	0.49	Sometimes
Throwing waste in designated bins.	3.15	0.75	Sometimes
Biking or walking to avoid carbon emissions,	3.02	0.85	Sometimes
Not using plastics or Styrofoam.	2.86	0.81	Sometimes
Eating less meat.	2.78	0.78	Sometimes
Turning food and garden waste into composts.	2.21	0.88	Rare

Moreover, students claimed that they avoided burning leaves, trash, and other materials (4.47); disposed or handled hazardous waste properly (4.46); used public transportation or carpooling (4.39); replaced incandescent light bulbs with compact fluorescent or LED (4.30); purchased energy-efficient appliances or advised parents to do it (4.28); refrained from using plastics or Styrofoam and supported eco-friendly materials (4.09); and preferred less meat for meals (4.03). Students were aware of the LGU ordinances about burning of waste. At home, some students were conscious about purchasing equipment or materials that are eco-friendly.

However, students were not consistent in reducing, re-using, reduction of waste materials (3.43); planting trees or vegetables to contribute to greening the environment (3.37); using bicycles, or walking to avoid carbon emissions (3.20); and they rarely turned food and garden waste into composts (2.21). Despite students' knowledge on solid waste management, lack of personal application as manifested from their responses in the questionnaire, was apparent. Also, they were knowledgeable of the principle of composting, but they rarely applied it at home.

Table 4
Outcomes /Applications of Integration of EE in Students' Skills Acquisition

Skills acquisition Outcomes	Mean	Standard Deviation	Verbal Description
Making eco-friendly cleaning solutions (home-made- e.g., use of vinegar and soda in soaking soiled clothes)	3.21	0.82	Sometimes
Putting up vertical garden at home and in ecofriendly pots.	3.21	0.94	Sometimes
Making cloth napkins.	3.20	0.86	Sometimes
Making decorations out of recyclable waste.	3.15	0.99	Sometimes
Making eco-friendly bags from recyclable materials.	1.96	1.03	Rare
Developing kitchen materials from eco-friendly materials (e.g., bamboo sipping tools than plastic straws; bowls made of bamboo than plastic bowls).	1.78	1.19	Rare
Making trash bins with proper labels to throw waste at home (e.g., non-biodegradable or biodegradable waste)	1.56	1.08	Rare
Crafting wooden toys for younger siblings or nephews and nieces.	1.56	1.24	Rare
Making furniture from eco-friendly materials.	1.51	1.16	Rare
Using eco-friendly light source.	1.50	1.27	Rare

Students had not regularly applied the skills they learned from their attendance to EE activities. Making eco-friendly cleaning solutions (home-made- e.g., use of vinegar and soda in soaking soiled clothes) (3.21), vertical gardening at home and using ecofriendly pots (3.21), using cloth napkins (3.20), and making decorations out of recyclable waste (3.15) were only "sometimes" done.

On rare occasions, students made eco-friendly bags from recyclable materials (1.96), kitchen materials from eco-friendly materials (e.g., bamboo sipping tools than plastic straws; bowls made of bamboo than plastic bowls) (1.78); trash bins with proper labels at home (e.g., non-biodegradable or biodegradable waste) (1.56); wooden toys for younger siblings or nephews and nieces (1.56); furniture from eco-friendly materials (1.51); and eco-friendly light source (1.50).

Again, findings on the outcomes of skills acquired by the students IEE, showed weak results as the feedback from the students manifested inconsistent application in their personal lives.

As to the outcome of the integration of EE on attitude, Table 5 shows that students believed they have important role in keeping the environment healthy (4.52) and were convinced that they can participate in solving negative effects of climate change (4.44). Students believed they became responsible in promoting environmental care in community (4.38) and had taken action to keep the natural world healthy (4.37). They were also enthusiastic supporters of activities for regreening efforts (4.37). The positive response of the students to these indicators could be attributed to their active participation in school/college-sponsored activities. The students developed a more ecological-friendly lifestyle (4.23) and they related well with the elements of the environment (4.13). However, students' response on their passion for greening activities (3.17) and in assuming leadership role to advance environmental protection (2.84), showed lower mean ratings. Apparently, involvement in these activities was only in fulfilling school requirements.

Table 5
Outcomes of Integration of EE in Students' Attitude

Outcomes on Attitude	Mean	Standard Deviation	Verbal Description
Being convinced of their important role in keeping the environment healthy.	4.52	0.75	Always
Believing that something can be done to solve negative effects of climate change.	4.44	0.74	Often
Becoming responsible in promoting environmental care in the community.	4.38	1.06	Often
Taking action to keep the natural world healthy.	4.37	0.83	Often
Being an enthusiastic supporter of greening activities.	4.37	0.85	Often
Developing confidence and good stewardship of the environment.	4.35	0.83	Often
Having a more ecological-friendly lifestyle.	4.23	0.70	Often
Relating well with the elements of the environment.	4.13	0.75	Often
Being passionate on greening activities.	3.17	0.74	Sometimes
Becoming a leader in advancing the cause of environmental protection.	2.84	1.06	Sometimes

Correlation of Student Knowledge Outcomes and Attitude Outcomes of IEE

The knowledge and skill outcomes were related with the attitude of the students on environment. The Pearson's r and *p* values are shown in Table 6.

Table 6
Correlation of Students' Knowledge and skills outcomes to their attitude

Variable	Pearson's r	*p* value	Decision	Interpretation
Knowledge and Attitude	.593**	.001	Reject Ho	Significant
Skills and Attitude	.647**	.001	Reject Ho	Significant

Note: **Correlation is significant at the 0.05 level (2-tailed)

Pearson's r value of 0.593 and *p* value <.05 significance level show that knowledge and attitude are significantly related. This means that the more knowledgeable the students were on EE, the better is their attitude. Likewise, Pearson's r value of .647 and *p* value<0.5 significance level indicates significant relationship between skills acquisition and attitude of the students.

Challenges in the Integration of EE in TE Programs

Table 7 shows the challenges of the teachers in integrating environmental education in teaching and learning.

Table 7
Challenges in the Integration of EE in TE Programs

Challenges Encountered	*f*	%
Inadequate knowledge about EE.	100	56.50
Inadequate time to allow activities for students that could have increased their environment literacy and involvement.	93	52.54
Unclear guidelines from the management on how to integrate EE.	76	42.94
Lack of memorandum or circulars from CHED or DepED regarding the integration of EE.	70	39.55
Inadequate stakeholders' support from the management to integrate EE.	60	33.90
Inadequate strategies to integrate EE into the curriculum.	58	32.77
Integration of EE is not a priority program supported in the school.	49	27.68
Lack of leadership to motivate the school stakeholders to strengthen the integration of EE in the curriculum.	46	25.99
Lack of learning resources to integrate EE extensively.	38	21.47
Teachers' heavy load that hinders more engaging activities to integrate EE in the curriculum.	33	18.64

Challenges of teachers in IEE were inadequate knowledge about EE (56.50%); lack of time to do activities with students that could have increased their environment literacy and involvement (52.54%); and heavy workloads which hindered their time in engaging activities to integrate EE in the curriculum (18.64%). In addition, lack of clear guidelines from the management on how to integrate EE (42.94%) and lack of memorandum or circulars from CHED or DepED (39.55%) were perceived to have affected their IEE. Likewise, there was a lack of support from the management to integrate EE (33.90%).

Another problem encountered was the lack of knowledge on effective strategies to integrate EE into the curriculum (32.77%). Teachers also claimed that IEE was not a priority program supported in the school (27.68%). Leadership to motivate the school stakeholders to strengthen the integration of EE in the curriculum (25.99) and learning resources to integrate EE extensively (21.47%) were also inadequate.

Proposed Enhancements to Fully Integrate EE in the TEPs

Based on the findings, the proposed enhancements in the integration of EE in the TEIs are shown in Table 8. The SUCs offering TEPs may adopt the program.

Table 8
Proposed Enhancements to Fully Integrate EE in the TEPs

Objectives	Strategies/Programs/Activities	Resources / Persons involved	Expected Result
Curriculum Content			
To enhance IEE in program outcomes and performance indicators for the BEEd curriculum	-An explicit statement on EA and action similar to the BSEd curriculum may be included.	Curriculum developers	Program Outcomes in the BEEd curriculum include statements on EA and care.
To add or retain EE in the GE courses in the BEEd program.	-EE was present in the CMO No. 30, series of 2004 under the Special Topics but was no longer recommended in the CMO No. 74, series of 2017 curriculum.	Curriculum Developers Respective school's Program Deans, Chairs and Faculty Respective school's Program Deans, Chairs and Faculty	EE is retained in the New Teacher Education Curriculum
To integrate EE in professional courses for both BEEd and BSEd, particularly in the OBTLs where learning environment is discussed.	Strategic inclusion of EE under the management of teaching-learning environment in the OBTLs	Respective school's Program Deans, Chairs and Faculty	EE is a part of the Professional Courses in discussion of teaching-learning environment
To add EE in other BSEd majors, not only in BSEd Social Studies.	Environmental Education may be added in the GE courses in other BSEd curriculum.	Respective school's Program Deans, Chairs and Faculty	EE is a part of the General Education Courses in BSEd Curriculum
Integration of EE Support			
Allot budgetary support for IEE in the TEPs.	Budget for integration of EE in the TEPs may be provided and must trickle down to the faculty members.	CHED, DBM, SUC presidents and Budget Officers	Budget to integrate EE in the BEEd and BSEd programs is adequate.
To include webinars/ seminars on integration of EE in the teaching -learning process in the Faculty Development programs.	SUCs may include webinars/ seminars and workshops for TEP faculty members to equip them with competencies for effective IEE.	Human Resources Deans Faculty members Resource speakers	Faculty members are fully equipped and competent in IEE.
Collaborate with school stakeholders for support to IEE.	Deans of TPEs may seek collaboration with school stakeholders for support in full IEE in BSEd and BEEd curricula.	Deans Faculty members	School Stakeholders other than management, faculty and teachers such as LGUs, community and parents are actively collaborating in IEE.

Discussion

Findings of the study showed that EE is integrated in the New Teacher Education Curriculum in both the BEEd and BSEd programs as shown in the implementation of the SUCs of the Policies, Standards and Guidelines provided in the CMO Nos. 74 &75, s. 2017. The program outcomes and performance indicators in the BSEd curricula have explicit statements about ensuring advocacy campaigns towards the attainment of sustainable goals, initiating stewardships of natural resources, participating in activities that promote environmental consciousness, and in integrating the environmental principles in teaching and learning. Similarly, the BSEd in Values Education, include planning and managing community development programs for values enhancement of the people in the community in the performance indicators. However, in the BEEd curriculum, there were no statements in the program outcomes and performance indicators that explicitly supported the EE integration. This is also true to some BSEd majors. Since EE is construed to transformative learning opportunities (North American Association for Environmental Education, n.d.), it must be a part of all educational programs.

In terms of the curriculum content, the mandated courses - PE and NSTP, included lessons intended to increase EA of students and encourage them to join environmental action. Moreover, STS is included in the General Education Courses in both the BEEd and BSEd programs in most SUCs and part of the STS content, lessons on EA, biodiversity and climate change were included. In BEEd curriculum, Environmental Science is a General Education course included in some SUCs. In the BSEd in Social Studies program, a major course, Human Geography, Physical Geography and Urban Geography heavily discusses EE and students taking up the course were led by the faculty in spearheading activities that promote environmental awareness and care.

In terms of the integration of EE in the teaching-learning process, teachers often reminded students to follow guidelines and laws related to environmental care such as abiding with solid waste management. Also, teachers took time to share about environment problems and issues whenever calamities occurred. Teachers claimed that these were opportune times to increase environmental awareness and care of the students.

As to the policies and guidelines that support the integration of EE in the TEPs, findings revealed that these were observed in all SUCs. The solid waste management program was strictly imposed in schools and the “no-smoking” policy, was a clear support to the “Clean Air Act “Law from the government. Energy-saving guidelines were also being instituted in schools.

The findings that showed lack of financial support for the integration of EE in schools were consistent with the findings of the study conducted by Mwenda (2017) in Tanzania where one of the teachers’ challenges was lack of support from each other and from the administration. The same findings were also shown in the study of Rahman et al. (2018) in Malaysia.

On the outcomes of the integration of the EE in the TEPs, students showed consistent positive attitude, except for developing passion for greening activities and leadership. Knowledge and skills application in real life settings, need improvement. The positive attitude of students in terms of environmental care are consistent with the results in the study of Erhabor and Don (2016) in Nigeria showing high level of students’ attitude in environmental care but a negative relationship between the knowledge and attitude was found. The authors recommended the need to promote and encourage the integration of EE in all educational levels in Nigeria. Likewise, Edsand and Broich (2019) found that EE had a weak effect to the environmental awareness and action among the students and recommended the need for more enhancements.

Another finding of the study is the positive correlation of knowledge (moderate) and skills (high) to the attitude of the students. These are manifestations of the need to intensify environmental education to see positive results on the students’ attitude.

As to the challenges encountered by teachers in the integration of EE in the curriculum, the most pressing ones were inadequate knowledge about EE; lack of time to allow activities for students that could have increased their environment literacy and involvement; and lack of clear guidelines from the management on how to integrate educational environment. According to some teachers, they have other responsibilities aside from teaching that limits their involvement in environmental action. These findings are consistent with the result of Marpa (2020) in a study in Philippine Normal University of Visayas- that among the challenges encountered in the integration of EE were the lack of curriculum materials, teaching competencies, and time. The challenges of the teachers in integrating EE in the curriculum were also similar to the findings of Benjamin and Adu (2019) in South Africa. Hence, the authors recommended for the development of curriculum with clear goals and the content with specific guidelines which shall develop teachers' capacity in integrating environmental education. Successful implementation of any educational policy largely depends on the teachers' competencies and support.

Conclusions and Implications

Environmental Education is integrated in the NETC based on the results and discussions presented in this study. The integration is clearly observed in curricular contents, especially in General Education courses and Mandated courses. Policies, guidelines, and programs are likewise apparent in all programs and supported by the administration. Faculty and students alike launch and participate in programs that promote environmental awareness and action. Teachers include EE in the teaching-learning process. However, program outcomes and performance indicators still lacked statements supporting EE, especially in the BEEd program. In addition, on the learning outcomes or the students' ability to apply the EE knowledge and skills in the real -life setting, findings imply the need to enhance integration strategies in such a way that students are not only active in attending school programs but also in applying what they learned in school at home and in their respective communities. Findings imply that EE integration in curricular programs help in promoting environmental knowledge, skills and attitude among students but involving other stakeholders, especially the family and the community are also needed so that application beyond school or classrooms is ensured. The study then recommends that schools should involve all stakeholders, especially families, in EE.

Moreover, results of the study have implications to the integration of EE in educational curricula across countries in the world. Since environmental problems are global, world leaders need to work together in addressing these interconnected global challenges. The results of the present study and the proposed enhancement of curricular programs may be significant inputs to the plans and strategies of countries in the world in their attempt to intensify integration of environmental education in their respective curricula, to achieve sustainability.

Recommendations

School administrators and teachers must institute better strategies to influence student application of knowledge and skills acquired from environmental education beyond classroom or school. The results of the study showed that involvement of students in environmental action were only tied to their school requirements but not in their personal lives. Teachers may consider requiring students to submit portfolios or journals on how they apply their EE knowledge and skills acquisition at home. Teachers may also ask students to develop reflection papers on environmental issues and the possible practical solutions. These activities will enable higher student engagement in environmental action, not only in school but also at home and in the communities. As to the teachers' challenges in IEE, giving thorough orientation and capability building activities are viable solutions.

The intervention measures proposed in this study maybe considered by curriculum developers, school heads/presidents/directors and teachers of all educational institutions across countries in the globe to strengthen the integration of EE in their respective curricular offerings. Future studies may explore the hindrances or factors that limit students' application of their learning acquisition in real-life settings.

Acknowledgement

The authors express their gratitude to the management of Tarlac State University, through the president, Dr. Myrna Q. Mallari and Bulacan State University, through Dr. Cecila S. Navasero-Gascon, the president, for the support and funding for the research.

Declaration of Interest

The authors declare no competing interest.

References

Abun, D. (2017). Environmental attitude and environmental behavior of Catholic Colleges' Employees in Ilocos Sur, Philippines. *Texila International Journal of Academic Research*, *4*(1), 1-30. https://doi.org/10.21522/TIJAR.2014.04.01

Benjamin, D., & Adu, E. O. (2019). Challenges teachers face in the integration of Environmental Education into the South African curriculum. *American Journal of Humanities and Social Science Research (IJHSSR)*, *03*(10), 157-166.

Boquet Y. (2017). Environmental challenges in the Philippines. In: The Philippine Archipelago (pp. 779-821). Springer Geography. https://doi.org/10.1007/978-3-319-51926-5_22

Carter, N., Bryant-Lukosius, D., DiCenso, A., Blythe, J., & Neville, A. J. (2014). The use of triangulation in qualitative research. *Oncology Nursing Forum*, *41*(5), 545-547. https://doi.org/10.1188/14.ONF.545-547

Climate Change Commission (2011). *National Climate Change Commission 2001-2018.* http://extwprlegs1.fao.org/docs/pdf/phi152934.pdf

Commission on Higher Education (2017). CMO No.75, s. of 2017. https://ched.gov.ph/wpcontent/uploads/2017/11/CMO No.-75-s

Commission on Higher Education (2017). *CMO No.75, s. of 2017*.

Commission on Higher Education (2016). *CHED Memorandum Order 52, s of 2016*. https://ched.gov.ph/wpcontent/uploads/2017/10/CMO-52-s.-2016.pdf

Commission on Higher Education (2012). CH*ED Initiatives in Strategizing HEIs for Climate Change Adaptation.* http://119.92.161.2/portal/Portals/20/Patlepam/Powerpoints/asian%20educators/RSS_CHED%20Initiatives%2on%20Climate%20Change_5November2013.pdf

Commonwealth of Education Hub (2020). *The role of education in propelling climate action.* https://www.thecommonwealth-educationhub.net/the-role of-education-in-propelling-climate-action/

Commission on Higher Education (2009). *CHED Memorandum Order No. 33, series of 2009.* https://ched.gov.ph/wp-content/uploads/2017/10/CMO-No.33-s2009.pdf

Department of Education (2021). *DepEd creates microsite for teaching climate change.* https://www.deped.gov.ph/2021/03/08/deped-creates-microsite-for-teaching-climate-change/

Department of Education (2020). *DepEd eyes strengthening of climate change awareness in basic education.* https://www.deped.gov.ph/2020/12/16/deped-eyes-strengthening-of-climate-change-awareness-inbasiceducation

Department of Education (2018). DM *019, s. 2018 – 2018 Activities of the Department of Environment and Natural Resources*. https://www.deped.gov.ph/2018/02/07/dm-019-s-20182018-activities-ofthedepartment-ofenvironment-and-natural-resources/

Department of Education. (2011). *DO No. 52, series of 2011.* https://www.deped.gov.ph/2011/07/05/do52-s-2011strengthening-environmental-education-in-public-and-private-schools/

Department of Education (2011). *Strengthening Environmental Education in Public and Private Schools*. https://www.deped.gov.ph/2011/07/05/do-52-s-2011-strengthening-environmentaleducation-in-publicand-private-schools/

DepED (n.d.). *Vision, mission and core values*. https://www.deped.gov.ph/aboutdeped/visionmission-core-valuesand-mandate/

Department of Environment and Natural Resources (2019). *DENR Secretary's Speech.* http://www.r5.denr.gov.ph/news-and-features/latest-news/3043-secretary-roy-a-cimatus-speeches.html

Environmental Management Bureau (n.d.). *Youth Program*. http://eeid.emb.gov.ph/?page_id=228

Environmental Protection Agency (2018). *What is environmental protection?* https://www.epa.gov/education/whatenvironmentaleducation#:~:text=Environmental%20education%20is%20a%20process,make%20informed%20nd%20responsible%20decisions

Erhabor, E. I., & Don, J. U. (2016). Impact of environmental education on the knowledge and attitude of students towards the environment. *International Journal of Environmental & Science Education*, *11*(12), 5367-5375. https://files.eric.ed.gov/fulltext/EJ1115646.pdf

Garcesa, R. D., & Limjuco, R. P. (2014). Environmental literacy and integration of environmental issues among Science teachers in Region X1: Basis for training design. *UIC Research Journal*, *20*(1), 207-225. https://ejournals.ph/article.php?id=13163

Global Climate Change (2021). *The effects of climate change*. https://climate.nasa.gov/effects/

Hershberger, M. (2014). 6 environmental challenges facing Southeast Asia (and what you can do to help). https://matadornetwork.com/change/6-environmental-challenges-facing-southeast

Labog, R. A. (2017). Teachers' integration of environmental awareness and sustainable development practices. *Asia Pacific Journal of Multidisciplinary Research*, *5*(3), 102-110. http://www.apjmr.com/wpcontent/uploads/2017/08/APJMR-2017.5.3.2.14.pdf

Malipot, M. (2019, April 6). Search for sustainable, eco-friendly schools launched. *Manila Bulletin*. https://mb.com.ph/2019/04/06/search-for-sustainable-eco-friendly-schools-launched/

Mandel, P. (2018). Children as change agents: The influence of integrating environmental education into home learning projects on families and community members. *Digital Commons*, 75-79. https://core.ac.uk/download/pdf/46946326.pdf

Marpa, E. (2020). Navigating environmental education practices to promote environmental awareness and education. *International Journal on Studies in Education*, *2*(1), 45-57. https://www.ijonse.net/index.php/ijonse/article/view/8/pdf

Mwendwa, B. (2017). Learning for sustainable development: Integrating environmental education in the curriculum of ordinary secondary schools in Tanzania. *Journal of Sustainability Education*, *12*, 1-15. http://www.susted.com/wordpress/wp-content/uploads/2017/02/Mwendwa-JSE-Feb-2017-GenerIssuePDF.pdf

National Education Association [(NEA), 2020]. *Climate Change Education: Essential Information for Educators.* https://www.nea.org/professional-excellence/studentengagement/tools-tips/climate-changeeducationessential

North American Association for Environmental Education (n.d.). *The Benefits of Environmental Education for K-12 Students*. https://naaee.org/eepro/research/eeworks/student-outcomes

Perez, R. B., & Bua, Jr., V. E. (2019). Greening the curriculum for sustainable development. Education Resources Information Center (ERIC) Data base. 1-15. https://files.eric.ed.gov/fulltext/ED600473.pdf

Rahman, N., Halim, L., Ahmad, A., & Soh, T. (2018). Challenges of environmental education: Inculcating behavioural changes among indigenous students. *Creative Education*, *9*, 43-55. https://doi.org/10.4236/ce.2018.91004

Sustainable Development Goals (2020). *About the Sustainable Development Goals*. https://www.un.org/sustainabledevelopment/sustainable-development-goals/

Statistics How To (2021). *Sample size in statistics (How to find it): Excel, Cochran's formula, general tips.* https://www.statisticshowto.com/probability-and-statistics/find-sample-size

Tsui, J. (2020). Five Biggest Environmental Issues Affecting the U.S. Five Biggest Environmental Issues Affecting the U.S. Environmental Protection, 1. https://eponline.com/Articles/2020/02/24/Five-Biggest-Environmental-Issues-Affecting-the-US.aspx?Page=1

United Nations Educational, Scientific, and Cultural Organization, n.d.). *Climate Change Education and Awareness.* https://en.unesco.org/themes/addressing-climate-change/climatechange-education-andawareness#:~:text=Education%20is%20an%20essential%20element,to%20climate%20change20related%20trends

United Nations Educational Scientific and Cultural Organization (UNESCO, 2019). *Climate Change Education*. https://en.unesco.org/

United Nations (2020). *The Climate Crisis – A Race We Can* Win. https://www.un.org/en/un75/climate-crisis-race-wecan-win

United States Agency for International Development (USAID, 2019). *Environment.* https://www.usaid.gov/philippines/energy-and-environment

Velimpini, K. (2016). The integration of environmental education in the secondary school curriculum: A case study of a 10th grade junior secondary school curriculum in the Okavango Delta, Botswana. https://etd.ohiolink.edu/!etd.send_file?accession=ohiou1451919034&disposition=inline

Verma, G., & Dhull, P. (2017). Environmental education as subject in schools. *International Journal of Advanced Research (IJAR)*, *5*(8), 1547-1552. http://dx.doi.org/10.21474/IJAR01/5214

Appendix A

Integration of EE Vis-à-vis the Policies, Standards and Guidelines provided in the CMO Nos. 74 &75, s. 2017

Program	**General Education Courses**	**Major/ Specialization Courses**	**Mandated Courses**	**Program Outcomes**	**Performance Indicators**
Bachelor in Elementary Education	Science, Technology and Society (STS) Learning Outcome under values: “Foster the value of a healthy lifestyle toward the holistic and sustainable development of society and the environment” (CHED, 2013) Environmental Science (in some SUCs)	Teaching Science in the Elementary Grades (Biology and Chemistry) Teaching Science in the Elementary Grades (Physics, Earth, and Space Science)	NSTP CMO No. 33, series of 2009 “Integration of EE in the Tertiary Educational Curriculum in the CWTS under the NSTP.” PE	-	-
BSEd in English	STS	-	NSTP PE	-	-
BSEd in Filipino	STS	-	NSTP PE	-	-
BSEd in Mathematics	STS	-	NSTP PE	Appreciate Mathematics as an opportunity for creative work, moments of enlightenment, discovery and gaining insights of the world.	-

BSEd in Science	STS	**Environmental Science**	NSTP PE	1.Apply scientific inquiry in teaching and learning. 2.Manifest meaningful and comprehensive pedagogical content knowledge (PCK) of the Sciences	-Apply the principles of scientific inquiry in solving current problems. -Use scientific inquiry in understanding and explaining natural phenomenon. -Create and utilize learning experiences inside the classrooms to develop learners’ skills in discovery learning, problem learning and critical thinking.

BSEd in Social Studies	STS	Human Geography, Physical Geography and Urban Geography	NSTP PE	1.To employ the principles of sustainable development in teaching and learning process. 2.Utilize appropriate various socio-cultural and historical materials explaining current issues. 3.Demonstrate leadership skills that will help in teaching and training students who will empower their communities. 4. Integrate local and global perspectives in teaching the principle of the common good. 5. Organize communities towards self-reliance and self-sufficiency.	-Initiate advocacy campaigns towards the attainment of sustainable goals. -Organize initiatives for stewardships of natural resources. -Participate in activities that promote environmental consciousness. -Integrate the environmental principles in teaching and learning. -Relate current events with available historical data to help students develop critical perspectives towards social issues. -Draw connections between and among people, events, and places to analyze local and global social issues.

BSEd in Values Education	STS	-	NSTP PE	1.Exhibit critical mindedness in analyzing local, regional, national, and global trends and issues relevant o values education. 2. Show passion and commitment in becoming advocate of universal values of openness, peace, tolerance, social justice, and respect for human rights. 3. Demonstrate commitment to students' development for personal renewal and social transformation. 4.Manifest commitment to community service to promote social values 5.Show reflective skills in applying strong moral and ethical principles in their decisions and actions as values education teacher.	-Engage learners in an in-depth discussion of current societal trends and issues. -Designing relevant curricular and co-curricular programs promoting universal values. -Utilizes different approaches for social transformation -Plan and manage community development programs for values enhancement of the people in the community. -Initiate and implement community service programs to promote values development for social transformation. -Engage in decision-making activities concerning moral and ethical values.
CMO No. 75, s. 2017				Graduates of State Universities and Colleges (SUCs) must have the competencies to support "national, regional, and local development plans.	

Received: *November 20, 2021* Accepted: *January 28, 2022*

Cite as: Corpuz, A. M., San Andres, T. C., & Lagasca, J. M. (2022). Integration of environmental education (EE) in teacher education programs: Toward sustainable curriculum greening. *Problems of Education in the 21st Century*, *80*(1), 119-143. https://doi.org/10.33225/pec/22.80.119

Alma M. Corpuz *(Corresponding author)*	Doctor in Educational Management (EdD in Educational Management), Master of Arts in Education General Education (MAED in Gen. Ed.), Faculty Member of College of Science, Tarlac State University, Tarlac City, Philippines. E-mail: almamarcelinocorpuz@gmail.com ORCID: https://orcid.org/0000-0002-0477-8317
Teody C. San Andres	PhD, Professor, Bulacan State University, Philippines. E-mail: teodysanandres.evp@bulsu.edu.ph ORCID: https://orcid.org/0000-0002-3298-1996
Julieta M. Lagasca	PhD, Professor, Tarlac State University, Tarlac City, Philippines. E-mail: jd_102885@yahoo.com ORCID: https://orcid.org/0000-0001-5396-0396

This is an open access article under the
Creative Commons Attribution 4.0 International License

PROBLEMS
OF EDUCATION
IN THE 21st CENTURY
Vol. 80, No. 1, 2022

PRE-SERVICE TEACHERs’ APPROACHES TO GUIDING STUDENTS IN PROBLEM SOLVING PROCESS

Fatma Cumhur
Muş Alparslan University, Turkey
E-mail: cumhurfatma@gmail.com

Abstract

Understanding students’ mathematical thinking in problem solving process plays an important role in facilitating the solution. Hence, teachers or pre-service teachers need to understand students’ thoughts and guide them to the correct answer. The aim of this study was to examine pre-service teachers’ approaches to guiding students in problem solving process. Designed as a case study, this study was carried out with five pre-service primary mathematics teachers. In the study, participants’ dialogues with 7th grade students were examined through 3 non-routine problems. The dialogues were transcribed and it was tried to reveal what kind of approaches the participants displayed. The content analysis was used in data analysis. The findings revealed that pre-service teachers followed Polya's problem-solving steps during their guiding approaches. Most pre-service teachers provided appropriate guidance in understanding the problem, selecting and implementing appropriate strategies for the problem; however, they failed to use the evaluative approaches sufficiently.

Keywords: *guiding approaches, multiple case study, pre-service teacher, problem-solving*

Introduction

A problem is defined, mathematically, as an issue that cannot be solved at first glance (Jonassen, 2000). In terms of teaching, a problem refers to an interesting question for which students do not know the solution, but have some preliminary information for the solution (Schoenfeld, 1989). In this respect, problem solving plays an important role in understanding mathematical knowledge and developing the relationship between this knowledge (Peterson, 1988). Problem solving is a crucial part of mathematics education and has a significant place in the curriculum. Basically, problem-solving is a learning process that reinforces, broadens, and deepens mathematical knowledge through the use of prior knowledge and experience. In this sense, Polya (1997) defines problem solving as a deliberate search for actions that can be taken to achieve the goal in the most reasonable way. Therefore, problem solving is not simply finding the result, but confronting new situations and producing creative solutions to these situations. Swing and et al. (1988) state that problem-solving is important in understanding mathematical knowledge and developing the relationship between this knowledge since the teachers’ answers to students’ thoughts help students to construct their reasoning and knowledge (Even & Markovits, 1995).

Problem-solving has an important role in questioning students' mathematical knowledge. It consists of vital cognitive processes such as understanding the sentence, selecting the necessary data for the solution, answering the problem, and deciding whether or not the answer makes sense (Baki, 2006). Considering that problem-solving is a mathematical activity process including many cognitive processes, it can be argued that the teacher has important responsibilities in this process. In this sense, teachers and pre-service teachers are expected to have strong pedagogical knowledge about guiding students in problem-solving process (Biber et al., 2017). The need for teachers to understand students’ thinking about mathematical concepts

https://doi.org/10.33225/pec/22.80.144

have been recognized as a teacher competency for a long time (National Council of Teachers of Mathematics- NCTM, 2000). In recent years, numerous studies on student thinking have emphasized the strong pedagogical knowledge of the teacher (Didiş et al., 2016; Wilson and et al., 2013) due to the fact that understanding and interpreting students' mathematical thoughts ensures an effective delivery of teaching activities (Carpenter et al., 1989; Roberts, 2021). It has been shown in many studies that teachers considering students' mathematical thoughts provide a more successful learning environment (Franke & Kazemi, 2001; Franke et al., 2009). However, studies on how teachers or pre-service teachers provide feedback to students, which strategies, and which questions they use in the problem solving process are limited (Didiş et al., 2016; Toluk-Uçar, 2011). In this sense, it is necessary to investigate how the teacher or pre-service teachers reveal the thoughts of the students and guide them in the problem solving process, where mathematical thoughts are the most intense.

The problem-solving process can be regarded as a complex process which requires thinking at all stages. According to Polya, systematic problem-solving facilitates cognitive learning. Polya (1997) examines these systematic phases in four parts: understanding the problem, making a plan for the solution, implementing the plan, evaluating it. Polya's steps are important in the problem solving process and for the teacher's guidance in this process. In this process, the teacher has the opportunity to observe the students, realize the mistakes and difficulties of the students, and make necessary interventions. It is important to determine where, how, and what kind of mistakes students make, as well as determining whether the answer is correct or incorrect in the problem-solving process since concepts, such as being aware of what the student does, realizing alternative solutions, exploring the relationships between, are more valuable than results in mathematics (Yavuz, 2006). Successful solution of the problem is achieved by developing unique solution strategies by using the connections related to the content instead of applying the solution with a specific algorithm. Therefore, teachers should be more interested in how the student obtained this result rather than the student's result itself, and question how the student solves the problem in the face of correct or incorrect answers (Lim et al., 2020). In such a case, teachers need to approach their students with some questions (Mason, 2020). In understanding and interpreting students' mathematical thoughts, teachers are expected to use questions that will reveal these thoughts (Aziza, 2021; Özdemir & Altay, 2016). In most studies, it has been observed that teachers or pre-service teachers use questions to reveal and interpret the thoughts of their students (Crespo, 2000; Çelik & Güzel, 2016; Moyer & Milewicz, 2002; Tanışlı, 2013). This reveals that questioning is a significant way to reveal students' thoughts. In such a situation, teachers are expected to address some questions to their students.

Some questions, for example, what does the problem want from us? (understanding the problem), what process steps can be followed? (developing a strategy), how do you practice the way you think? (implementing a strategy), is there any other solution? (evaluating) give students a systematic perspective in the problem-solving process. Teachers often make use of some questions in problem-solving process for such reasons as improving students' understanding and making connections between concepts (Ilaria, 2009). In addition, the Turkish Ministry of National Education-MoNE (2013) emphasizes some teacher behaviors such as problem solving, reasoning, association, listening to students' answers and communicating effectively with them. Depending on these behaviors, teachers definitely need to ask questions. The emphasis is not on how teachers will question, but on how to develop a dialogue with students (Moyer & Milewicz, 2002). Dantonio and Beisenherz (2001) described this process as encouraging students to think critically about their answers, rather than just hearing the teacher's answers. In this context, the questions used in the problem-solving process also emphasize the quality of the teacher's guiding approach. In this process, educators should be capable of guiding with productive, impressive, and thought-provoking questions (Dong et al., 2019; Kabar et al., 2020; Mahmud, 2021; Martino & Maher, 1999).

It is among the aims of the new education system that teachers guide the student with their questions and enable the student to discover new things (MoNE, 2013). The aim of the guiding approach is to help students reveal their thoughts and learning processes through questions (Ge & Land, 2003) and help them reach their solutions (Lin & Lehman, 1999). Using this approach, teachers can include students to the process more quickly for purposes such as questioning, associating, connecting, identifying, evaluating and remembering misconceptions (Rosenshine et al., 1996). Although pre-service mathematics teachers studying at education faculties in Turkey have some knowledge about the difficulties, misconceptions, and mathematical thinking styles of students as a part of the courses they take (Higher Education Council-YÖK, 2006), their knowledge about guiding students and revealing their thoughts with questions is limited. The literature on problem solving shows that the researchers have frequently focused on students' problem-solving success, problem solving skills, and problem-solving strategies, ignoring the issue of how approaches are used to guide students to the solution. However, in the problem solving process, it may be essential to reveal the students' approaches to the question, and to ask them some questions with an aim to reveal their thoughts. Therefore, even if the student makes mistakes, it is required to question the underlying reasons of these mistakes and to guide the student with appropriate questions, which is an important pedagogical component a teacher should have. Although the studies in the literature emphasized this pedagogical competence, they failed to provide adequate information on the difficulties experienced in the process and the approaches pre-service teachers use. In this sense, the present study is significant in that it tries to deal with the problem solving process in more detail and to offer predictions that will shed light on other studies which investigate the approaches used by pre-service teachers. For this reason, this study aimed to reveal how pre-service teachers guide students in the problem-solving process and which questions they use in this process. For this purpose, solutions were sought for the following research questions:

- How do pre-service primary school mathematics teachers guide students in the problem solving process?
- Which questions do pre-service primary school mathematics teachers use while guiding students in the problem solving process?

Research Methodology

General Background

Multiple case – holistic design study was used in this research. In the multiple case study, factors related to two or more situations are used to understand the similarities and differences within and between cases with a holistic approach (Yin, 2014). In this way, in-depth research is carried out on how they affect the situation as well as how they are affected (Yıldırım & Şimşek, 2013). The cases in this study were five pre-service primary school mathematics teachers. Therefore, it was aimed to present the guiding approaches of pre-service teachers in a realistic and holistic way in the natural environment.

Research Group

The participants of the study consisted of five 4th grade pre-service primary school mathematics teachers studying at Mathematics education department in a state university. The participants were pre-service teachers under the supervision of the researcher in Teaching Practice course and thus a convenience sampling method was used in the selection of the participants. The participants had taken several theoretical and practical courses such as Problem Solving Strategies, Mathematical Modeling, Special Teaching Methods, Teaching Practice. In these courses, the pre-service teachers had the opportunity to learn different teaching techniques as well as having different experiences on how to reveal the students' thoughts. Particularly, some of the applications they made within the scope of Problem Solving Strategies and Mathematical Modeling courses provided them ideas on how to approach problems and how to guide students. For example, the pre-service teachers who learned the problem solving steps of Polya (1997) attempted to use these steps in all problems. In addition, as a part of Special Teaching Methods course, they learned different approaches and different types of questions. Furthermore, in Teaching Practice course, they had the opportunity to test their knowledge and skills in real classroom environment and gained experience in establishing a dialogue with the students and asking them different questions. When they needed to guide the students facing a problem, they adhered to the steps of Polya (1997) and paid attention to ask appropriate questions in a way that would lead the students to the answer at each step. Thus, they had experience in establishing a dialogue with the students and for this reason they were included in the study.

Since the aim of this study was to provide a general framework for the guiding approaches used by pre-service teachers rather than reaching a generalization, it was deemed sufficient to examine a limited number of participants in detail. Because qualitative research is accepted as a research method that aims to examine the researched subject in depth with a small number of people. In relevant quotes in the findings section, pre-service teachers were coded as PT1, PT2, PT3, PT4, and PT5 and students as S1, S2, S3, S4, and so on.

Data Collection

Dialogues with 7th grade students directed by pre-service teachers in the face of 3 non-routine problems were used in this study. The dialogues firstly video-recorded and then transcribed. Finally, it was tried to reveal the kind of approaches the pre-service teachers used and the questions they used.

The following criteria were taken into consideration in the selection of non-routine questions used by the participants: the questions need to be thought-provoking; they should be solved with different strategies, they should have different solutions, and they should provide the opportunity to create different models. In line with these criteria, several sources were reviewed, the appropriate problems were listed, and the most suitable 3 questions were selected for the study. The selected problems are as follows:

1. A tourist group of 228 people wants to look at the city at the top of a high building. There is only one elevator in the building with a capacity of 24 people. How many tours must the elevator take to get the whole group to the top of the building?
2. Aunt Ayşe decides to go to the market for holiday shopping. However, she needs to do her shopping in a short time. Aunt Ayşe sees that there is a queue at the cash register. There can be a minimum of 3 and a maximum of 7 items in the cash register. Considering that the barcodes are read in 3 seconds and all products are packaged in 20 seconds at a time, develop and express your own mathematical model, and answer the questions below in accordance with the model you developed.

a) Considering that Aunt Ayşe is in the 6th place, what is the minimum time it takes for Aunt Ayşe to take the turn?
b) Considering that Aunt Ayşe is in the 6th place, what is the maximum time it takes for Aunt Ayşe to take the turn?

3. You are thinking of making a long call on your phone. According to the tariff of the line you use, the first minute of the call is charged 100 cent, and 20 cents for each minute in the ongoing call. For this phone call, develop a mathematical model to express your debt for any t call duration.

The participants performed practicum with groups of 3-4 students. First of all, a participant raised a problem to the whole group and started a discussion with a student. The other students observed the discussion between the teacher and the student and expressed their opinions when questions were posed to them. In this way, each problem solving process was carried out in about 20-30 minutes in different turns.

Data Analysis

In the study, it was aimed to reveal how the pre-service teachers approached the students in the problem-solving process, and thus the approaches they adopted in this process were examined in detail. The content analysis method was used for data analysis since the pre-service teachers’ approaches in problem solving process were examined. The aim of content analysis is to reveal the concepts and relationships that help to explain the obtained data (Çepni, 2012). In educational research, diaries, written texts and interview transcripts are generally examined using content analysis (Patton, 2002). In the study, category analysis of content analysis techniques was used (Yıldırım & Şimşek, 2013). At this stage, the researcher created a code-category-theme system. In this sense, the researcher analyzed the information he obtained and tried to divide it into meaningful parts and to understand what each part means conceptually. These sections, which form a meaningful whole in themselves, were named by the researcher. In this context, the transcripts of the interviews of each participant were examined carefully and the guiding approaches they adopted were tried to be determined. The questions that the participants asked the students during the problem-solving process revealed the general structure of the guiding approach. In this way, the questions used by the participants were grouped and each group was examined under a different theme. An excerpt of a participant’s dialogue with the student is taken and how the content analysis was carried out is represented below.

> PT2: Well, let me give you an example in this question. You, 12 people, go to dinner in a restaurant and the elevator in the restaurant can only carry 5 people, how can you solve this question.
> S2: Teacher, 12 is divided by 5 and remains 2. Again it is a decimal number.
> PT2: Let's think about it, friends, for example, the two of you remaining, the two of you, you are the only ones down, how would you go up.
> S2: (Two students pointed out): We would go up with a separate elevator
> PT2: Right, so how many tours would it be?
> S2: There would be 3 tours in total
> PT2: Well done children, let's try to apply the solution steps for our own question, just as we have solved this problem.
> S2: Teacher, then the answer to our question is 10 because the remaining 12 people make separate tours.

In order to reveal the approach of the participant in the dialogue, first of all, his/her purpose was examined. Throughout the dialogue, the participants’ answers to the student helped to reveal his/her purpose. For this reason, it was understood that the approaches used by the participants to student answers were related to "How?" rather than "What?". This required that all statements used by the candidate throughout the dialogue must be analyzed. Since content analysis requires more analysis than observation, all statements were carefully read and analyzed in the study. As a result of the analysis, the fact that the participants generally used questions to provide answers and guided the students with questions required the need to group these questions. In this sense, various themes were created in line with the purposes of the questions used throughout the dialogue and a general structure was revealed as a result of these themes.

Research Results

Preservice Teachers' Approaches to Guiding

The findings showed that participants generally followed Polya's (1997) steps in problem solving process and directed the students in accordance with these steps. While performing these steps, participants generally preferred to ask questions during the problem-solving process in order to reveal the students' thoughts and overcome the difficulties they faced. The question types they used showed that participants mostly used the questions to guide students to the solution and to probe their answers. The participants' use of Polya (1997)'s steps and questions to perform these steps enabled the use of different question types. The participants also used these questions in a particular order in accordance with the steps of Polya (1997): questions that require an understanding of the problem (Do you understand the question?), questions that require determining a strategy (What is your idea for a solution?), questions that require implementing a strategy (How do you solve it?), and questions that require evaluation of the solution (Do you understand the solution?). Following this sequence, the participants asked the students questions such as guiding, searching, identifying misconceptions, connecting, role playing and re-focusing. The following figure shows the approaches and question types the participants used in general:

Figure 1
The Participants' Approaches to Guiding in Problem-Solving Process

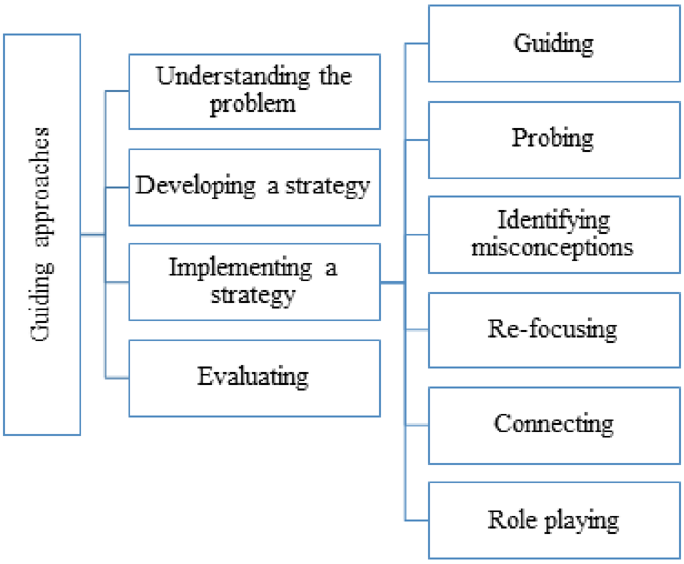


Figure 1 illustrates a general outline of the approaches and question types the participants used in their problem solving process. Some excerpts of the dialogues of the participants with the students under these headings are presented as follows:

Understanding the Problem

The participants generally adopted approaches to reveal whether the students understood the problem after they asked the problem. Some participants tried to understand whether the students understood the problem with closed-ended questions whereas others used open-ended questions. For example:

PT1: Do you understand the question?
S1: Yes
PT1: How do we solve the question?

The dialogue showed that the pre-service teacher asked the problem to the students and then tried to find out whether the problem was understood with 'yes' or 'no' question. Similarly,

PT2: Do you understand the question?
S2: Yes.
PT2: Well! If you solve it, I will follow your solution.

In this dialogue, PT2 led the student directly to the solution process without revealing the understood parts of the problem. A different participant asked the problem to the group and initiated the solution part directly with the question *'Does anyone want to solve this question?'* without checking whether the students understood the problem. The participant focused directly on problem-solving rather than guiding his/her students to problem-solving and developing appropriate solution strategies. In contrast, another participant checked whether the student understood the problem in detail as follows:

PT3: Did you read and understand the question?
S3: Yes, teacher
PT3: Can you explain?
S3: (explains 3rd problem) 100 cent in the first minute, 20 cents in the next minutes, but what does "t" mean?
PT3: If "t" means one minute-talk or 10 minutes-talk, we use a letter such as x, y, z since it is variable.

As seen in the dialogue, the student stated that he/she understood the problem at first but when the pre-service teacher requests for an explanation it was revealed that he/she did not fully understand the problem. This shows that such questions as "Did you understand the question? "are not adequate to understand students' thought and thus detailed questions such as "What do you understand from the question?" should be asked.

PT4: How would you explain the question clearly if you wanted to tell me?
S4: (explains 1st problem) Teacher, in this question, there is a tourist group of 228 people, people in this group want to go upstairs, but there is a lift for 24 people in the building, and this question asks how many tours we will take these people up!
PT4: Well done! You explained the question in a very nice way.

In this dialogue, the participants aimed to reveal the clarity of the problem with an open-ended question and encouraged the student to explain the problem in detail.

S5: Teacher, I did not understand this question.
PT5: Okay, now let's read it together to understand the question. Now, be the person in this question, okay? (3rd problem).
S5: Yes, teacher.
PT5: Now, you are going to have a long call on the phone, and the first minute of this phone's tariff is 100 cents. If you talk on the phone for a longer time and this time is not known, except for the first minute you will pay 20 cents for every other minute. Now, do you understand this question?
S5: Yes, teacher, I understood the question, but why time of the call is not clear, then how can we solve it?

As seen in the dialogue, the participant explained the problem with more descriptive words. It is noteworthy that the participant considered the student as the protagonist of the problem and connected the problem with the student's daily life. However, the fact that the student expressed that he/she did not understand the problem sufficiently showed that the participant's explanatory attitude was not sufficient.

Developing a Strategy

During the strategy development phase, students are expected to make a connection between what is given and what is required, to predict which process steps can be followed, and to make preliminary trials for a solution. In this process, the participants generally asked the students the question "how can we solve them?" and aimed to present the students' solutions. However, it was seen in some dialogues that the solution strategies were not sufficiently revealed. For example,

> PT1: How do we solve the question?
> S6: We will divide 228 people into 24 and find out how many tours the elevator will go.
> PT1: What is the result?
> S6: 9

In this dialogue, the participants focused on finding the result immediately after presenting the student's solution strategy. In a different dialogue,

> PT2: Do you understand the question?
> S7: Yes.
> PT2: So you solve it, I will follow.

After the student's statement that he/she understood the problem, the teacher led the student directly to the solution and did not reveal the student's ideas about the problem. In addition, it was seen that another participant did not take into account the steps of understanding the problem and developing a strategy and led the students to a solution with the question" who wants to solve this question?" A different participant adopted the following approach in developing strategy.

> PT1: If you wanted to solve this question, how would you go on, what procedures would you use?
> S6: Teacher, I would use division in this question.
> PT1: So, why would you use the division?
> S6: Because, teacher, we have to take people up and down. So, I believe we could find the number of tours this way.

It is seen that the participant aimed to present the student's solution strategy with a more questioning approach. In general, participants tried to reveal students' thoughts in the context of strategy development, but they used less questions that would require extensive and detailed information. It was noted that participants did not show any approach in order to establish a connection between what was given and what was required in this process or to discuss students' solution strategies.

Implementing a Strategy

The participants observed students during the implementation of the strategy and posed questions in the process. It is understood that pre-service teachers tried to achieve goals such as directing, researching, connecting and refocusing students with these questions. The participants often asked students to re-focus when the students made mistakes. In addition, they asked questions to identify misconceptions, connect, and demonstrate purposes to guide students in situations where they had difficulties.

Guiding

The guiding approach plays a facilitating role in reaching the solution if the students are unable to answer or provide incorrect or incomplete answers. In this case, the participants tried to simplify the process by dividing the question to simple steps and giving clues to the students.

PT4: Can you find a formula for this?
S8: I don't know how to find it.
PT4: Well, let me explain to you, let's find it together. Let's say x is our product number, so in how many seconds are each product read.
S8: 3
PT4: So how many seconds is the total product read?
S8: 3.x
PT4: How much time is it for packaging?
S8: 20
PT4: How many people do you expect if you are the 6th person?
S8: 5
PT4: Why?
S8: Because we get ourselves out 6-1 = 5
PT4: Well, if there are that many k and we are the third, then we subtract ourselves from k, right?
PT4: So let's write the formula
S8: (x.3 + 20). Number of persons = (x.3 +20) (k-1).

The examination of the dialogue showed that the student did not know how to approach the solution. More importantly, the participant preferred to ask questions in a way that led the student to a step-by-step solution. These questions revealed that the participant did not guide student to improve his/her problem-solving and algebraic reasoning skills. Instead, it was seen that the participant directly led the student to a solution through hint questions that made it easier to obtain answers.

Probing

The probing approach allows students to deepen their ideas on the subject and to think more comprehensively about their answers. With these questions which include high-level thinking skills, students are expected to develop reasoning, analyzing, interpreting, and critical thinking skills.

PT3: First solve by taking the value 10, and then write the variable.
S9: 10-1 = 9, 9.20 = 180, 180 + 100 = 280
PT3: Why did you subtract 1?
S9: Because the first minute is already clear.
PT3: If t were then 10, it would still be a subtraction. Then write algebraically, subtracting 1 minute from the time t
S9: t-1
PT3: Then why multiply 9 and 20?
S9: Because it was 20 seconds for the rest.

It was seen in the dialogue that the participant used questions that require inquiring the answer of the student in the solution process. This reveals that the participant used questions to examine the inter-quantitative relationships in the problem.

S10: Teacher, we tried to solve this question, but we didn't come up with a full answer. We found 9.5.
PT4: How did you reach this answer?
S10: In this question, we divided the number 228 to 24 and the result was 9.5. So the elevator should make 9.5 tours.
PT4: Why did you divide?
S10: Teacher, since we have grouped people here, and the division process is used when grouping.

The dialogue showed that the student's inability to find the result as an integer caused confusion in the student. The participant exhibited a probing approach with questions such as “how did you reach that result?” and “Why did you do the division?”. This helped the students to deepen their answers.

Identifying Misconceptions

Most students have misconceptions. In order to eliminate misconceptions during the course, questions are often used. Therefore, predicting the parts students will face a challenge and asking questions to overcome the difficulty is an important task for teachers.

PT1: So what should you do with t-1?
S11: t-1.20
PT1: Is t-1.20 equal to (t-1) .20?
S11: Yes
PT1: Can you multiply two expressions, let's see is it equal?
S11: t-20, 20t-20
PT1: Is it equal?
S11: No, but which one is right, teacher?
PT1: We subtracted 1 from 10 and multiplied the whole by 20, so what?
S11: I have to multiply the whole, so (t-1) .20

The answer in the dialogue revealed that the student had a misconception. On the other hand, the participant helped the students realize his/her mistake instead of providing an immediate feedback. It is seen that the participants aimed to eliminate the misconceptions of the student and achieve his/her aim with the questions.

Re-focusing

The refocus approach aims to refocus students on key points in the problem when they move away from the correct way. This approach was frequently used by the participants.

PT2: You understood the question well, but you thought incorrectly in somewhere. So, does anybody want to explain this?
S12: But teacher, the division is the correct way for this question, we have solved a similar problem to this question without being left.

The fact that the participant stated that the solution was incorrect showed that he/she refocused the students on the question. However, the fact that he/she used a general expression stating that *" you thought incorrectly in somewhere "* and did not mention specific points were not sufficient for students to understand exactly what the focus would be. A similar situation was observed in another participant’s dialogue:

PT1: Friends, it is correct to divide in this question, but you make a mistake in somewhere. Does anybody want to explain what the mistake is?
S13: No teacher, we did not understand the mistake.

In a different dialogue, it was seen that the participant tried to make up for the student's insufficiency as follows:

PT5: Well done, you are very close to solving the problem, but your answer is missing, do you want to find?
S5: But teacher it is the right solution.
PT5: Well, Is the first spoken minute certain?
S5: Yes, teacher, it is certain and 100 cents.
PT5: Yeah. In this algebraic expression, we show the first minute as (t-1), right? Because the first spoken minute was 100 cents, or we subtracted it.
S5: Yes, teacher.
PT5: So how can we use an algebraic expression or equation in this question?
S5: Teacher, then 100+ (t-1) .20

It is understood that the participants aimed to conclude the student's incomplete answer in this dialogue. Seeing that the student's solution had not yet reached a conclusion, the participant guided the student to focus on the question again. However, it is noteworthy that the statements of the participant were in a way that would enable the student to close this gap himself/herself rather than allowing the student to see the lack of solution. Here, instead of focusing on the points where the student made mistakes, the participant preferred explanatory questions instead of focusing on the points where the student made mistakes.

Connecting

The connecting approach aims to connect different aspects of a situation or to link it to real life. In this approach, it is aimed to compare two or more situations and to reveal similarities or differences. In the study, the participants frequently used connecting strategies and mostly aimed to establish connections with daily life.

PT2: Well, let me give you an example in this question. You, 12 people, go to dinner in a restaurant and the elevator in the restaurant can only carry 5 people, how can you solve this question.
S2: Teacher, 12 is divided by 5 and remains 2. Again it is a decimal number.
PT2: Let's think about it, friends, for example, the two of you remaining, the two of you, you are the only ones down, how would you go up.
S2: (Two students pointed out): We would go up with a separate elevator
PT2: Right, so how many tours would it be?
S2: There would be 3 tours in total
PT2: Well done children, let's try to apply the solution steps for our own question, just as we have solved this problem.
S2: Teacher, then the answer to our question is 10 because the remaining 12 people make separate tours.

When the students could not find the answer, the participants tried to provide a simple example and tried to establish a connection between the problem and daily life by engaging the students in the event. The participants' simplification and connection strategies contributed to the students' problem-solving.

S4: I did the operation and found 3.2, so it should be a 3.2.
PT4: Well, how do we make 3.2 tours?

S4: Teacher, but the result should be 3.2.
PT4: Would not we do a full tour, going upstairs with our family
S4: Yes, teacher.
PT4: So, in other words, are we able to go up to the top floor as a decimal number?
S4: No, teacher, I got it, what my friends say is, they are going to go up in a separate time because the elevator can only make a full tour. It cannot make a decimal tour.
PT4: Well done, you thought right.

Similarly, in this dialogue, it is seen that the student had difficulty in understanding and the participant tried to overcome this difficulty by connecting the situation with daily life.

S12: Yes, teacher, I understand the question, but why is it not clear how long we talk, then how can we solve this question?
PT2: You know, we learned algebraic expressions before.
S12: Yes, teacher, we did.
PT2: Let's remember algebraic expressions with a few examples before moving to the question.
S12: Okay, teacher.
PT2: What is 2 more of a number?
S12: If we call the number "a", it would be a + 2, teacher
PT2: Good. Now there is an unknown expression in this question, or how do you write this algebraic expression in the question.
S12: Then we'll find out it 100+ 20th.

In this dialogue, the participant made a connection with the student's prior knowledge and established a bridge between the information given in the problem and this information.

Role playing

The role playing approach aims to act out the incomprehensible problem in accordance with the environment. This approach, which is considered as gamification, has enabled students to understand the problem better. Not every problem is suitable for role playing, which makes this approach less common than others.

PT3: Friends, let's solve this question practically. Now, in turn, let's get out of here as seven people.
S13: Teacher, my friend and I stayed here, what will we do.
PT3: What do you think your friends should do in this step?
S13: Teacher, they can also come in a separate tour. So, the answer will be 4 tours.

In this dialogue, the participant responded to the students who persistently misrepresent the result, and used role playing approach by acting out a similar situation. The participant took different values appropriate to the role play instead of the values in the problem, enabled the students to understand the problem better. The participant also used approaches to reveal the students' solution strategies during the acting out of the problem. In response to the student's incorrect answers, he/she made the student realize his/her mistake by asking questions that would establish connections with daily life. It was seen that the students establishing a connection between the values in the problem through role playing got the correct result.

Evaluating

The evaluation approach aims to determine whether the problem is understood, what results will be achieved when different values are given, or to seek different solutions. This approach was often ignored by the participants. Instead, they thought that it would be sufficient to find the result and they did not exhibit any further approaches. At this stage, the participants checked whether or not the problem was understood with simple questions such as "Did you understand?". They did not ask questions that revealed how they would form the problem in different situations.

PT4: Can you tell me the solution to the problem again?
S14: Teacher, it is now 100 cents in the first minute, this fee is certain, the other minutes t-1, the first minute we took this algebraic expression. We will write 100, and then we will multiply t-1 by 20 for the other minutes. The debt will be 100+ 20. (t-1).
PT4: Well done, you understood very well what I told you. Your solution is correct.
S14: Yes.

In this dialogue, it is seen that the student explained the solution to the problem with their own statements and the pre-service teacher tried to clarify the unclear points.

PT1: Well, is there anyone who did not understand the logic of this question?
S1: No, teacher.

In this dialogue, the participant regularly revealed the comprehensibility of the solution and did not provide further details.

Discussion

It was found in the present study that learning new and contemporary approaches during their undergraduate education helped the participants integrate the knowledge they learned into practice. Their questions about understanding the problem and developing a strategy in students' problem-solving process showed that the process of understanding the problem and making a plan for the solution was taken into account before the solution process. Most studies have highlighted the importance of cognitive steps such as understanding the problem as the first step in the problem-solving process, establishing a relationship between what is given and what is required, and choosing strategies that can be used for solution (Memnun, 2014; Turnuklu & Yesildere, 2005). In addition, it was stated in the literature that inadequate definition of the problem will pave the way to difficulties for students in the problem solving process (Gökkurt & Soylu, 2013; Karataş & Güven, 2004). It was revealed that the part that was not understood cannot be expressed with some questions such as 'Do you understand the problem' and 'How do you solve it' used in these steps. The students provided surface level answers to these questions. However, questions such as 'what did you understand from the problem' and 'why did you choose this strategy' allowed the students to focus on the problem and the solution and to provide more detail. Thus, the students initiated a better solution process by clarifying the points that were not understood at the beginning of the process. It was stated in most studies that the questions used in the process affected students' thinking and pushed them into a better solution process (Doerr, 2006; Graham et al., 2021; Yenmez et al., 2017).

During guiding, the participants used questions that serve the purpose of guiding, questioning, identifying misconceptions, re-focusing, connecting, and role playing. Although it was found that questions such as connecting and re-focusing were used more frequently, the structure of the problem was decisive in the type and amount of the question to be used. The question types showed that they successfully helped the participants to lead students to reach the solution to the problem. However, it should be noted that only some of the questions facilitated more student thinking because pre-service teachers may have difficulty in controlling the progress of the conversation in the process. In such cases, they may prefer to use more explanatory questions rather than being thought-provoking. On the other hand, explanatory questions can prevent the student from thinking when the answer is considered confidential. Nevertheless, effective questions facilitate students' high-level thinking (Dong et al., 2019; Schjem, 2021; Yenmez et al., 2017).

Pre-service teachers believe that it is necessary to show their students the ability to handle a problem in various ways while solving a problem (Kayan & Cakıroglu, 2008). In the present study, the participants enabled students to realize their mistakes by intervening in the questions when the students made a mistake, Garcia et al. (2010) stated that the prompts to be used when students have difficulties in the solution process are the responsibility of the teacher. In particular, making connections with daily life and role playing were effective in concretizing the situation. Similar results were found in some studies such as Yenmez et al. (2017) and Galbraith and Stillman (2006). However, some questions, such as 'you're in the wrong place?', which were asked to refocus students on the problem when they were distracted from the answer, failed to focus students on the key point. In such a case, the pre-service teacher's emphasis on the wrong part and focusing on the dimensions of the error may provide more effective answers.

Answering the problem easily cannot be accepted as proof of good problem solving skills (Yavuz, 2006). Problem-solving is not only an ability to achieve results but a process that requires thinking at all stages. It requires thinking at all stages of the process (Kukey, Aslaner & Tutak, 2019). This can be regarded as a good indication that problem-solving is not only an ability to achieve results. Some questions such as 'is it understood?' were at the surface level and did not force students to elaborate on what they understand in detail. Polya (1997) discussed the evaluation step in the problem solving process in detail and offered students a more inquisitive approach in finding different ways and retrying the solution with different values. It is emphasized in some studies that different solutions should be included and these solutions should be discussed in the classroom (Cai & Kenney, 2000; Kayan & Cakıroglu, 2008). Although pre-service teachers believe that problem-solving is process-oriented, their practices are result-oriented (Biber et al., 2017). Pre-service teachers may think that the solution is sufficient when students answer the problem and they may not need different questions to develop additional strategies. The fact that the participants wanted to complete the problem-solving process in a short time and regarded only one answer sufficient led them to provide insufficient guidance in the evaluation phase. Similarly, in some studies, it has been observed that pre-service teachers have a result-oriented approach in the problem-solving process (e.g. Biber et al., 2017).

Conclusions and Suggestions

The findings of this study showed that the participants followed the following problem solving steps of Polya (1997) in the guiding approaches in problem solving process: understanding the problem, developing a strategy, implementation of a strategy, and evaluating. In the problem-solving process, the participants generally followed the students' solutions and were able to respond to the difficulties faced by the students during the solution. During the implementation of the strategy, they preferred some approaches such as identifying misconceptions, connection, re-focusing, and role playing, when students had difficulty in understanding. In addition, the participants focused on finding the result in the problem-solving process, but they did not put much effort to evaluate the result. On the basis of the finding of the present study, it is recommended to enhance the practicum opportunities that will enable the development of guidance approaches of pre-service teachers and to promote such studies. Problem solving should not be regarded only as a part of the mathematics course, instead it should be considered as a facilitating factor that can be used at every stage of human life. In this regard, it is important to examine and develop the pedagogical approaches teachers or pre-service teachers use in order to improve students' problem-solving skills.

The present study is not without its limitations. First, the study was carried out with five participants. Second, student levels were ignored. Third, only three questions were used to examine the participants' approaches. These limitations indicate that different results can be obtained when the study is conducted under different conditions. In this sense, studies can be conducted to see what kind of results can be obtained by observing student levels and using different problems in different studies. In this sense, student levels should be considered in future studies and different problems should be used. In addition, increasing the number of the participants or including in-service teachers may lead to different results.

References

Aziza, M. (2021). A teacher questioning activity: the use of oral open-ended questions in mathematics classroom. *Qualitative Research in Education*, *10*(1), 31-61. https://doi.org/10.17583/qre.2021.6475

Baki, A. (2006). *Kuramdan uygulamaya matematik eğitimi* [Mathematics education from theory to practice]. Derya Bookstore.

Biber, B. T., Aylar, E., Ay, Z. S., & İspir, O. A. (2017). İlköğretim matematik öğretmen adaylarının problem çözmeye dair pedagojik alan bilgilerinin sınıf içi gözlem ve görüşme yoluyla belirlenmesi [Pre-service primary school mathematics teachers' pedagogical content knowledge of problem solving through interviews and in-class practice observations]. *Kastamonu Education Journal*, *25*(4), 1483-1498. https://dergipark.org.tr/tr/pub/kefdergi/issue/30766/332494

Cai, J., & Kenney, P. A. (2000). Fostering mathematical thinking through multiple solutions. *Mathematics Teaching in the Middle School*, *5*(8), 534-539. https://doi.org/10.5951/MTMS.5.8.0534

Carpenter, T. P., Fennema, E., Peterson, P. L., Chiang, C. P., & Loef, M. (1989). Using knowledge of children's mathematics thinking in classroom teaching: An experimental study. *American Educational Research Journal, 26*(4), 499–531. https://doi.org/10.3102/00028312026004499

Crespo, S. (2000). Seeing more than right and wrong answers: Pre-service teachers' interpretations of students' mathematical work. *Journal of Mathematics Teacher Education, 3*(2), 155–181. https://doi.org/10.1023/A:1009999016764

Çelik, Ö. A., & Güzel, B. E. (2016). Bir matematil öğretmeninin ders imecesi boyunca öğrencilerin düşüncelerini ortaya çıkaracak soru sorma yaklaşımları [A mathematics teacher's questioning approaches for revealing students' thinking during lesson study]. *Turkish Journal of Computer and Mathematics Education*, *7*(2), 365-392. https://doi.org/10.16949/turcomat.67541

Çepni, S. (2012). *Araştırma ve proje çalışmalarına giriş* [Introduction to research and project work]. Celepler Printing.

Dantonio, M., & Beisenherz, P. C. (2001). *Learning to question, questioning to learn: Developing effective teacher questioning practices*. Allyn & Bacon.

Didiş, M. G., Erbaş, A. K., & Çetinkaya, B. (2016). Matematik öğretmen adaylarının öğrenci hatalarına yönelik pedagojik yaklaşımlarının matematiksel modelleme bağlamında incelenmesi [Investigating prospective mathematics teachers' pedagogical approaches in response to students' errors in the context of mathematical modeling activities]. *Elementary Education Online, 15*(4), 1367-1384. https://doi.org/10.17051/io.2016.75429

Didiş, M. G., Erbaş, A. K., Çetinkaya, B., Çakıroğlu, E., & Alacacı, C. (2016). Exploring pre-service secondary mathematics teachers' interpretation of student thinking through analysing students' work in modelling. *Mathematics Education Research Journal*, *28*(3), 349-378. https://doi.org/10.1007/s13394-016-0170-6

Doerr, H. M. (2006). Examining the tasks of teaching when using students' mathematical thinking. *Educational Studies in Mathematics, 62*, 3–24. https://doi.org/10.1007/s10649-006-4437-9

Dong, L., Clarke, D., Cao, Y., Wang, L., & Seah, W. T. (2019). Teacher questioning practices over a sequence of consecutive lessons: A case study of two mathematics teachers. *Sustainability*, *11*(1), 139 . https://doi.org/10.3390/su11010139

Even, R., & Markovits, Z. (1995). Some aspects of teachers' and students' views on student reasoning and knowledge construction. *International Journal of Mathematical Education in Science and Technology, 26*(4), 531-544. https://doi.org/10.1080/0020739950260407

Franke M.L., & Kazemi E. (2001). Learning to teach mathematics: Focus on student thinking. *Theory into Practice*, *40*(2), 102-109. https://doi.org/10.1207/s15430421tip4002_4

Franke, M. L., Webb, N. M., Chan, A. G., Ing, M., Freund, D., & Battey, D. (2009). Teacher questioning to elicit students' mathematical thinking in elementary school classrooms. *Journal of Teacher Education, 60*(4), 380-392. https://doi.org/10.1177/0022487109339906

Galbraith, P. L., & G. Stillman. (2006). A framework for identifying student blockages during transitions in the modelling process. *ZDM – Mathematics Education, 38*(2), 143–162. https://doi.org/10.1007/BF02655886

García, F. J., K. Maass, & G. Wake. (2010). Theory meets practice: working pragmatically within different cultures and traditions. R. Lesh, P. L. Galbraith, C. R. Haines, & A. Hurford (Eds.), *Modeling Students' Mathematical Modeling Competencies* (pp. 445–457). Springer. https://doi.org/10.1007/978-1-4419-0561-1_38

Ge, X., & Land, S. M. (2003). Scaffolding students' problem-solving processes in an ill-structured task using question prompts and peer interactions. *Educational Technology Research and Development*, *51*(1), 21-38. https://doi.org/10.1007/BF02504515

Gokkurt, B., & Soylu, Y. (2013). Öğrencilerin problem çözme sürecinde anlam bilgisini kullanma düzeyleri [Levels of students' use of semantic knowledge in problem solving process]. Kastamonu Education Journal, *21*(2), 469-488. https://app.trdizin.gov.tr/makale/TVRRM09ESTNOdz09/ogrencilerin-problem-cozme-surecinde-anlam-bilgisini-kullanma-duzeyleri-

Graham, M. A., van Staden, S., & Dzamesi, P. D. (2021). Communicating lesson objectives and effective questioning in the mathematics classroom: The ghanaian junior high school experience. *International Journal of Instruction*, *14*(4), 965-984. https://doi.org/10.29333/iji.2021.14455a

Ilaria, D. R. (2009). *Teacher questions that engage students in mathematical conversation*. [Unpublished doctoral dissertation]. Rutgers University.

Jonassen, D. H. (2000). Toward a design theory of problem solving. *Educational Technology: Research and Development, 48*(4), 63–85. https://doi.org/10.1007/BF02300500

Kabar, M. G. D., & Tasdan, B. T. (2020). Examining the change of pre-service middle school mathematics teachers' questioning approaches through clinical interviews. *Mathematics Teacher Education and Development*, *22*(1), 115-138. (EJ1272255). https://eric.ed.gov/?id=EJ1272255

Karatas, I., & Guven, B. (2004). Determining the problem solving skills of 8th grade students: A case study. *Journal of National Education*, *163*. http://dhgm.meb.gov.tr/yayimlar/dergiler/Milli_Egitim_Dergisi/163/karatas.htm

Kayan, F., & Cakiroglu, E. (2008). İlköğretim matematik öğretmen adaylarının matematiksel problem çözmeye yönelik inançları [Preservice elementary mathematics teachers' mathematical problem solving beliefs]. *Hacettepe University Journal of Education*, *35*(35), 218-226. https://dergipark.org.tr/tr/pub/hunefd/issue/7803/102288

Kukey, E., Aslaner, R., & Tutak, T. (2019). An investigation of the problem solving strategies used of middle school students for of the assumption component of mathematical thinking. *Journal of Computer and Education Research, 7*(13), 146-170. https://doi.org/10.18009/jcer.535610

Lim, W., Lee, J. E., Tyson, K., Kim, H. J., & Kim, J. (2020). An integral part of facilitating mathematical discussions: Follow-up questioning. *International Journal of Science and Mathematics Education*, *18*(2), 377-398. https://doi.org/10.1007/s10763-019-09966-3

Lin, X., & Lehman, J. D. (1999). Supporting learning of variable control in a computer-based biology environment: Effects of prompting college students to reflect on their own thinking. *Journal of Research in Science Teaching: The Official Journal of the National Association for Research in Science Teaching*, *36*(7), 837-858. https://doi.org/10.1002/(SICI)1098-2736(199909)36:7<837::AID-TEA6>3.0.CO;2-U

Mahmud, M. S. (2021). Implementation of oral questioning in assessing student learning in mathematics teaching in primary schools. *Turkish Journal of Computer and Mathematics Education (TURCOMAT)*, *12*(5), 137-143. https://doi.org/10.17762/turcomat.v12i5.805

Martino, A. M., & Maher, C. A. (1999). Teacher questioning to promote justification and generalization in mathematics: What research practice has taught us. *Journal of Mathematical Behavior, 18*(1), 53-78. https://doi.org/10.1016/S0732-3123(99)00017-6

Mason, J. (2020). Effective questioning and responding in the mathematics classroom 1. G. Ineson & H. Povey (Eds.), *Debates in mathematics education* (2nd ed., pp. 131-142). Routledge. https://doi.org/10.4324/9780429021015

Memnun, D. S. (2014). Beşinci ve altıncı sınıf öğrencilerinin sözel problemleri çözme konusundaki yetersizlikleri ve problem çözümlerindeki hataları [Fifth and sixth grade students' deficiencies on word problem solving and failures in the problem solving process]. *Turkish Journal of Computer and Mathematics Education, 5*(2), 158-175. https://dergipark.org.tr/tr/pub/turkbilmat/issue/21573/231491

Ministry of National Education [MoNE]. (2013). *Secondary school mathematics curriculum* (grades 5, 6, 7 and 8). Ankara.

Moyer, P. S., & Milewicz, E. (2002). Learning to question: Categories of questioning used by preservice teachers during diagnostic mathematics interviews. *Journal of Mathematics Teacher Education*, *5*(4), 293-315. https://doi.org/10.1023/A:1021251912775

National Council of Teachers of Mathematics [NCTM] (2000). *Principles and standards for school mathematics.* https://www.nctm.org/uploadedFiles/Standards_and_Positions/PSSM_ExecutiveSummary.pdf

Özdemir, İ. E. Y., & Altay, M. K. (2016). Sınıf Öğretmeni Adaylarının Öğrencilerin Matematiksel Düşüncelerini Ortaya Çıkarma ve Yorumlama Becerileri [Pre-service primary teachers’ skills in revealing and interpreting students’ mathematical thinking]. *Elementary Education Online*, *15*(1), 23-39. https://doi.org/10.17051/io.2016.92637

Patton, M. Q. (2002). *Qualitative research and evaluation methods* (3rd ed.). Sage Publications.

Peterson, P. L. (1988). Teachers' and students' cognitional knowledge for classroom teaching and learning. *Educational researcher*, *17*(5), 5-14. https://doi.org/10.3102/0013189X017005005

Polya, G. (1997). *How to solve it?* (Trans: F. Halatci). Sistem Publishing.

Roberts, S. A. (2021). Learning and unlearning through questioning practices: Middle grades mathematics teachers' transformations to support english learners. *Mathematics Teacher Education and Development*, *23*(1), 135-155. https://orcid.org/0000-0002-7191-9175

Rosenshine, B., Meister, C., & Chapman, S. (1996). Teaching students to generate questions: A review of the intervention studies. *Review of educational research*, *66*(2), 181-221. https://doi.org/10.3102/00346543066002181

Schjem, T. (2021). *Questioning questioning: The" why" and" how" of mathematics* [Unpublished master's dissertation]. Norwegian University of Science and Technology.

Schoenfeld, A. H. (1989). Explorations of students’ mathematical beliefs and behavior. *Journal for Research in Mathematics Education, 20*(4), 338-355. https://doi.org/10.2307/749440

Swing, S. R., Stoiber, K. C., & Peterson, P. L. (1988). Thinking skills versus learning time: Effects of alternative classroom-based interventions on students' mathematics problem solving. *Cognition and Instruction*, *5*(2), 123-191. https://doi.org/10.1207/s1532690xci0502_2

Tanışlı, D. (2013). İlköğretim matematik öğretmeni adaylarının pedagojik alan bilgisi bağlamında sorgulama becerileri ve öğrenci bilgileri [Preservice primary school mathematics teachers’ questioning skills and knowledge of students in terms of pedagogical content knowledge]. *Education and Science*, *38*(169). http://egitimvebilim.ted.org.tr/index.php/EB/article/view/1736

Toluk-Uçar, Z. (2011). Öğretmen adaylarının pedagojik içerik bilgisi: Öğretimsel açıklamalar [Preservice teachers’ pedagogical content knowledge: instructional explanations]. *Turkish Journal of Computer and Mathematics Education*, *2*(2), 87-102. https://dergipark.org.tr/tr/pub/turkbilmat/issue/21564/231439

Türnüklü, E. B., & Yeşildere, S. (2005). Problem, problem solving and critical thinking. *Gazi University Journal of Education*, *25*(3), 107-123. https://dergipark.org.tr/tr/pub/gefad/issue/6755/90828

Wilson, P. H., Mojica, G. F., & Confrey, J. (2013). Learning trajectories in teacher education: Supporting teachers’ understandings of students’ mathematical thinking. *Journal of Mathematical Behavior, 32*(2), 103–121. https://doi.org/10.1016/j.jmathb.2012.12.003

Yavuz, G. (2006). *The effect of problem solving strategy teaching on affective characteristics and access in ninth grade mathematics course* [Unpublished doctoral dissertation], DEU Institute of Educational Sciences.

Yenmez, A. A., Erbas, A. K., Cakiroglu, E., Cetinkaya, B., & Alacaci, C. (2017). Mathematics teachers’ knowledge and skills about questioning in the context of modeling activities. *Teacher Development*, *22*(4), 497-518. https://doi.org/10.1080/13664530.2017.1338198

Yıldırım, A., & Şimsek, H. (2013). *Sosyal bilimlerde nitel araştırma yöntemleri* [Qualitative research methods in the social sciences]. Seckin Publishing.

Yin, R. K. (2014). *Case study methods: Design and methods* (5th ed.). Sage Publishing.

Yüksek Öğretim Kurumu (YÖK). (2006). *Eğitim fakültesi öğretmen yetiştirme lisans programı: sınıf öğretmenliği lisans programı ders* içerikleri [Faculty of Education Teacher Training Undergraduate Program: Classroom Teaching Undergraduate Program Course Contents]. http://www.yok.gov.tr/documents/10279/49665/sinif_ogretmenligi.pdf/32dd5579-2e4d-454e-8c91-5e0594ebdf48

Received: *November 03, 2021* Accepted: *January 24, 2022*

Cite as: Cumhur, F. (2022). Pre-service teachers' approaches to guiding students in problem solving process. *Problems of Education in the 21st Century*, *80*(1), 144-161. https://doi.org/10.33225/pec/22.80.144

Fatma Cumhur

PhD, Assistant Professor, Mathematics and Science Education Department, Muş Alparslan University, Diyarbakır Yolu 7. km, 49250 Merkez/Muş,
Turkey.
E-mail: cumhurfatma@gmail.com
ORCID: https://orcid.org/0000-0001-5891-564X

This is an open access article under the
Creative Commons Attribution 4.0 International License

PROBLEMS
OF EDUCATION
IN THE 21st CENTURY
Vol. 80, No. 1, 2022

SITUATION OF SPECIAL EDUCATION IN BRAZIL AND CANADA DURING THE COVID-19 PANDEMIC

Rosana Carla do Nascimento Givigi
Federal University of Sergipe, Brazil
E-mail: rosanagivigi@gmail.com

Denise Meyrelles de Jesus
Federal University of Espírito Santo, Brazil
E-mail: jesusdenise@hotmail.com

Raquel Souza Silva
Federal University of Sergipe, Brazil
E-mail: fgaraquelsouza@gmail.com

Abstract

The Covid-19 pandemic has placed the world in a public health emergency since the beginning of the year 2020, posing a challenge to education, especially to Special Education. This study aimed to analyze the situation of special education in Brazil and Canada during the Covid-19 pandemic. The research was part of a postdoctoral project in education. Methodologically, it is an international comparative study in education. It was carried out from April 2020 to November 2021, based on a literature review and official documents. The search was carried out in the Scientific Electronic Library Online (SciELO) and in the Institute of Educational Sciences (ERIC), and 233 articles were found. After analysis and following the inclusion criteria, 217 articles were excluded. In the end, 16 studies were selected. The results show that the more structured the educational system and Special Education, the greater the chances of success. In addition to returning to face-to-face classes earlier, Canada also provided more support for families and students, but it was still insufficient. In both countries, children with disabilities are in a fragile situation owing to social isolation. Aspects such as choice of tools, internet connection quality, user skills, virtual spaces for collective support, school and family communication, strengthening of special education policies and programs, adequate support, among others, led to the success of remote education. This research is intended to contribute to an increase in the number of studies in Brazil and abroad, serving as a basis for the scientific production of other international comparative studies.

Keywords: *Covid-19, special education, comparative study, literature review, Brazil and Canada*

Introduction

The situation caused by the Covid-19 pandemic has had different impacts on people’s lives in different parts of the world. When it emerged in China in 2019, no one imagined it would spread beyond the boundaries of Southeast Asia. At that time, measures such as isolation and extensive testing were adopted, with hopes that they would be enough. However, this is not what happened; a highly transmissible virus and a world where the flow of people from one country to another is constant facilitated the establishment of a public health emergency situation. The world scenario has worsened, as became evident in Europe, North America, Africa, and South America.

Worldwide, this situation brings different impacts to continents and countries, and in this case, the socioeconomic factors are determinant. When it comes to developing countries,

https://doi.org/10.33225/pec/22.80.162

e.g., Brazil, the population is more vulnerable when compared to that of developed countries, and in the sub-Saharan region of Africa, health conditions are even more alarming, because the population's vulnerability is even greater (Arroio, 2020; Santos et al., 2020).

The data as of November 20, 2021 has confirmed 256 million cases of Covid-19 and 5.13 million deaths worldwide. Brazil, a country with 210.1 million inhabitants, had 22 million cases and 612,000 deaths caused by Covid-19. Canada, on the other hand, is a country with a population of 37,703,512 and there were 1,765,164 cases and 29,485 deaths from Covid-19 (World Health Organization 2021). The proportional comparison has shown 5.14% of the Brazilian population versus 2.33% of the Canadian population, as regards the number of cases; as far as number of deaths is concerned, 0.12% of the Brazilian population versus 0.06% of the Canadian population. These data enable the detection of several implications of Covid-19 on the Brazilian and the Canadian societies. The numerous effects include: protection; homeschooling; inequality in access to remote education; childcare issues; access to health; the economic crisis (Oleschuk, 2020; St-Denis, 2020; Unesco, 2020a).

An important implication was the strict isolation measures, which directly interfered with people's well-being. At the educational level, the measures were diverse: for example, the closing of schools, or reduced schedules and rotation among groups; strict operation protocols to control the virus; among others. As one of the measures of social isolation, an average of 1.6 billion students in the world have stopped going to school and are home-schooled in more than 190 countries (Unesco, 2021). School shutdowns affect not only students' learning, but also their socio-emotional aspects. In addition, as schools closed, teachers had to adapt to remote teaching and families had to bear the structure and support for homeschooling (Mustafa, 2020).

With all the changes in education, several countries have implemented supportive actions. In Scotland, the government created a program for volunteers to provide support to families; in Jamaica, the government implemented online platforms that provided educational, dietary, and health guidance; in China, the government implemented sanitary, educational, and health measures to ensure well-being; in the United States, remote teaching was monitored and districts were required to create strategies to ensure educational performance; in New Zealand, a range of library and classroom materials were released for free virtual reading; in Brazil, the state authorities created online teaching platforms, and support materials and teacher training were provided; in Canada, educational institutions reorganized themselves in a short period of time, and significantly increased the capacity to teach remotely; also, curricula were made more flexible (Lingjie & Zhanfang, 2020; Santos et al., 2020; Unesco, 2020b).

According to previous studies, school shutdowns have caused negative results in student learning, especially for economically disadvantaged students. Some reasons are: parents' difficulty in keeping up with school assignments, lack of access to digital platforms, lack of human interaction, teachers' and students' lack of digital skills, inappropriate learning methodologies for remote teaching (Martinez et al., 2021; Mikušková & Verešová, 2020; Mustafa, 2020).

While school education had problems worldwide to reorganize itself during this period, the prevailing hypothesis was that the problems are even greater when taking into account the perspective of Inclusive Education and attempting to ensure the right to education for people with disabilities. Thus, this study aimed to analyze the situation of special education in Brazil and Canada during the Covid-19 pandemic, based on a comparative study. The main research question was: What was the situation of special education in Brazil and Canada during the Covid-19 pandemic?

Research Methodology

General Background

This comparative study in education aims to identify the similarities and differences that are the result of the dialectical relationship between global and local (Tan et al., 2016). In this study, the method was employed to organize, study, and analyze scientific and informative articles and legislations regarding Brazilian and Canadian special education during the Covid-19 pandemic, comparing the actions taken to ensure the learning of students targeted by special education. The comparison was done between Brazil and Canada because the Canadian public school system is a high-quality system that Brazil wants to emulate. Furthermore, in both countries, public schools are the responsibility of the provinces/states, and schools were closed for a long period during the pandemic.

Published articles were searched in the Scientific Electronic Library Online (SciELO) and the Institute of Education Sciences (ERIC) from April 2020 to November 2021, using the search words Covid-19 and special education. Searches were also performed on the official websites of the Ministries of Education of the two countries.

Instrument and Procedures

The survey was conducted from April 2020 to November 2021. To answer the research question, a review of the literature was performed. The search for articles was performed by two authors/evaluators who discussed the intersection of the following descriptors: in Portuguese corresponding in English: "covid-19" and "special education”. Thus, the bilingual vocabulary (English/Portuguese) was used – Descriptors in Thesaurus, available in the databases Scientific Electronic Library Online (SciELO) and the Institute of Education Sciences (ERIC). In addition, the official websites of the ministries of education of the two countries were searched.

Data Extraction

At first, the descriptors were “covid-19” and “special education”. A total of 11 and 222 articles were found in the SciELO and in ERIC databases, respectively. The next step was to carry out subsequent, independent, individual readings of the titles and of the abstracts, respectively, without identifying the authors or platforms used for the publication of the studies. Two researchers were in charge of article selection, following the previously established eligibility criteria.

After analysis of the titles and abstracts, articles that had Brazil and/or Canada as a spatial cutout were selected. The search resulted in 31 articles that actually dealt with special education during the Covid-19 pandemic in both countries. The 31 articles were read in full and 16 of them were used, as shown in Table 1 (Results section). Next, the official websites of the Ministries of Education of the two countries were searched.

Brief introduction to Brazil and Canada

Brazil and Canada were part of this research. The interest was to understand how education authorities the two countries organized themselves to provide educational assistance to Special Education students (Robson et al., 2014). This information was collected in articles and through the analysis of legal and guiding educational and Special Education documents during the pandemic period. Importantly, the pandemic period continues, despite being more controlled.

Brazil is a country with 210.1 million inhabitants, with a territorial area of 8,515,767.049 km² according to the Brazilian Institute of Geography and Statistics (Instituto Brasileiro de Geografia e Estatística [IBGE], 2021). In Canada, there are 37,703,512 inhabitants, in a territorial area of 9,985,000 km² (https://countrymeters.info/pt/Canada). Brazil's Gross Domestic Product (GDP) in 2018 was R$6.9 trillion, and the country ranked 79th in the Human Development Index (HDI). A report by the United Nations Development Programme (UNDP) pointed out that Brazil had the 2nd highest concentration of income in the world, with 1/3 of all wealth in the hands of the richest 1% (UNDP, 2019). Canada's GDP, on the other hand, was approximately $1.627 trillion, and the country ranked 13th in the Human Development Index (HDI) with a high index, with only 8% of the population living below the poverty line (UNDP, 2019).

Brazil is a federative republic made up of 26 states and the Federal District, where Brasília, the capital of the country, is located. The Federative Republic of Brazil is a presidential republic, and although it is divided into states, it has a central government; all the states are subordinated to the Federal Constitution of Brazil and to the federal legislation.

Canada, on the other hand, is made up of ten provinces and three different territories. The provinces have a certain degree of autonomy from the federal government, with their own laws and taxes. Territorially, autonomy from the federal government is smaller. Canada is a constitutional monarchy and a federal state with a democratic parliament. In addition to the power of a monarch, there is that of the constitution, enforced by the country's prime minister. The capital of the country is Ottawa, located in the province of Ontario (Berg & Bernd, 2017).

For this reason, Canada has significant differences in the administration of the different districts, since the provinces have a certain degree of autonomy from the federal government, with their own systems and laws, including those relative to education.

Research Results

During the research, in a first search with the descriptors "covid-19" and "special education", 233 articles were found in the databases. In the first stage, the titles and abstracts of the works were read. After this reading, 202 articles were excluded because they were not studies in either Brazil or Canada. At the end of this first stage, 31 articles remained, which were read in full; 15 of them were excluded for dealing with studies on gender, immigrants or ethnicity.

Table 1 describes 16 studies selected after screening with data corresponding to: author, title, year of study. The studies are shown in the Table in the order in which they appear in the discussion.

Table 1
Characteristics of the Studies

Nº of the Study	Authors/Year	Title
Study 1	Rodrigo Mendes Institute (2020)	Protocolos sobre educação inclusiva durante a pandemia da Covid-19: Um sobrevoo por 23 países e organismos internacionais. [Protocols on inclusive education during the Covid-19 pandemic: An overflight by 23 countries and international organizations]
Study 2	Arruda, E. P. (2020)	Educação Remota Emergencial: elementos para políticas públicas na educação brasileira em tempos de COVID-19 [Emergency Remote Education: elements for public policies in Brazilian education in Covid-19 times]
Study 3	Torres, J. P., & Borges, A. A. P. (2020)	Educação especial e a Covid-19: o exercício da docência via atividades remotas [Special education and Covid-19: the exercise of teaching via remote activities]
Study 4	Conde, P. S., Camizão, A. C., & Victor, S. L. (2020)	Pandemia e atividades remotas: possibilidades e desafios para a educação especial [Pandemic and remote activities: possibilities and challenges of special education]
Study 5	Silva, K. W., Bins, K. L. G., & Rozek, M. (2020)	A educação especial e a Covid-19: aprendizagens em tempos de isolamento social [Special Education and Covid-19: Learning in Times of Social Isolation]
Study 6	Neta, A. D. S. O., Nascimento, R. D. M. & Falcão, G. M. B. (2020)	A educação dos estudantes com deficiência em tempos de pandemia de Covid-19 ***[*** The education of students with disabilities in times of the Covid-19 pandemic]
Study 7	El-Zraigat, I., & Alshammari, M. (2020)	The Psychological and Social Effects of COVID-19 Outbreak on Persons with Disabilities
Study 8	Best, L. A., Law, M. A., Roach, S., & Wilbiks, J. M. P. (2020)	The Psychological Impact of COVID-19 in Canada: Effects of Social Isolation During the Initial Response
Study 9	Wotto, M. (2020)	The future high education distance learning in Canada, the United States, and France: Insights from before Covid-19 secondary data analysis
Study 10	Van Nuland, S., Mandzuk, D., Tucker Petrick, K., & Cooper, T. (2020)	Covid-19 and its effects on teacher education in Ontario: a complex adaptive systems perspective
Study 11	Frenette, M., Frank, K., & Deng, Z. (2020)	School Closures and the Online Preparedness of Children during the COVID-19 Pandemic
Study 12	Russo, K., Oliveira Soares, R., Magnan, M. O., & Borri-Anadon, C. (2020)	Droit à la santé ou droit à l'éducation? Inégalités en éducation pendant la première vague de la Covid-19 au Québec

Study 13	MacDonald, M., & Hill, C. (2021)	The educational impact of the Covid-19 rapid response on teachers, students, and families: Insights from British Columbia, Canada
Study 14	Fontenelle-Tereshchuk, D. (2021)	‘Homeschooling’and the COVID-19 Crisis: The Insights of Parents on Curriculum and Remote Learning
Study 15	Shafer, K., Scheibling, C., & Milkie, M. A. (2020)	The Division of Domestic Labor before and during the COVID-19 Pandemic in Canada: Stagnation versus Shifts in Fathers’ Contributions
Study 16	Riegel, A. B., Marques, L. N., & Wuo, A. S. (2021)	Legislation that guides teaching for students with disabilities in times of pandemic – COVID-19

Discussion

To analyze the situation of Special Education in Brazil and Canada in times of pandemic, a brief overview is presented for educational policies focused on inclusive education in these countries. In both countries, educational policies are the result of the process of internationalization of the right to education and the political, economic, and social specificities of each country. As a common ground, in both countries the goal of educational policies is the schooling of people with disabilities in regular education, but the Brazilian special education policy, from the perspective of inclusion, is more recent than Canada’s: almost 30 years apart (Kassar et al., 2019; Smith, 1981).

Since the 1980s, Canada has made it compulsory for people with disabilities to be included in school. There are several support programs for students with disabilities, different support systems, and the receipt of resources for Special Education. In Brazil, however, the support system for students with disabilities is a sore point, and resources are divided between public and private education, which makes it extremely dependent on the dominant political positions (Han, 2018; Kassar et al., 2019; Smith, 1981).

In the vast majority of districts in Canada, the school structure is able to guarantee access and permanence of students with disabilities in the regular school, and the programs provided for in the special education policy guidelines articulate the individual processes proposed for students with disabilities and the class process (Alberta, 2013, 2016; British Columbia, 2016; Ontario, 2017; Québec, 2006). In Brazil, despite the policy providing for this articulation, the school system has difficulties in implementing this proposal (Brazil, 2008). However, regardless of the scope of the educational policy in Brazil or in Canada, the person with disabilities has a very diverse demand for support. As it is not possible to separate education from other policies and living conditions, people with disabilities living in Brazil have greater vulnerability compared to people with disabilities in Canada, which has a higher human development index (HDI) and greater guarantees of human rights (Dantas, 2017).

The Covid-19 pandemic, since the beginning of the year 2020, has triggered a Public Health Emergency situation, and the World Health Organization (WHO) declared the severity of the disease caused by the new coronavirus (SARS-CoV-2). This situation has brought about a great transformation in the lives of people from different countries; undeniably, the greatest impacts have been found to occur for the most socially vulnerable people. In Brazil, which has great social inequality, most inequalities refer to access to the Internet and to equipment, as well as the condition to acquire digital skills (Rodrigo Mendes Institute, 2020).

Special Education and the Pandemic in Brazil

According to data from the National Institute of Educational Studies and Research Anísio Teixeira (Instituto Nacional de Estudos e Pesquisas Educacionais Anísio Teixeira [INEP], 2020), in Brazil, there are more than a million students with some kind of disability enrolled in regular classes. It seems logical that social isolation increases exclusion. In Brazil, the federation shared with the states and municipalities the responsibility for organizing the implementation of educational activities. Face-to-face classes were suspended in virtually all states, and one of the alternatives was remote classes. Children started to study online, and traditional face-to-face classes were shifted to the virtual environment. According to a research study by Rodrigo Mendes Institute (2020), in Brazil there is a lack of infrastructure for homeschooling and based on the Tecnologias da Informação e Comunicação (TIC) Domicílios survey [a survey on the use of Information and Communication Technologies in Brazilian households], it was found that "among the C class households, 43% had a computer and Internet access, and 33% had only Internet connection [without a computer]. Most households in classes D and E had neither access to a computer nor to the Internet (58%)" (Instituto Rodrigo Mendes, 2020, p.6). These data show that, in Brazil, exclusion begins with access to remote education.

In Brazil, special norms were adopted for the pandemic period. Following the timeline of the documents, Arruda (2020) stated that a precise and cohesive proposal was not instituted at the federal level. This can be seen in the ordinance nº 343/2020, which institutes remote teaching (Portaria n. 343, 2020), and the provisional measure nº 934, which determines as flexible the mandatory number of school days (Medida Provisória n. 934, 2020). Then, the National Council of Education (CNE) issued Directive no. 5, which reorganized the calendar and the workload for remote activities (Parecer CNE/CP n. 5, 2020). The document includes Special Education students, and explicitly guarantees the provision of specialized educational care (AEE), with support for families, the development of individual teaching plans, and support for more specific actions such as the Brazilian Sign Language (Libras), alternative communication or special systems for students with disabilities (Parecer CNE/CP n. 5, 2020). Following the timeline, Directive no. 11 (Parecer CNE/CP n. 11, 2020) provides guidelines for classes and pedagogical activities in the context of the pandemic. While the opinion report states that students in Special Education must follow the same rules for returning to classes, it provides a series of guidelines on physical contact, the use of masks, etc., simplifying the issue of people with disabilities. In August 2020, Law No. 14,040 established special educational standards to be adopted during the state of public calamity (Lei n. 14.040, 2020).

The schools closed in March 2020 and so far, (March 2021) the return has been still partial. In most states, only private education has returned, and in a hybrid format. This situation shows the lack of infrastructure in the Brazilian educational system (e.g., in certain areas, schools do not have internet access and/or computers), and lack of training on hybrid teaching for teachers.

Analyzing the situation of Special Education in Brazil during the pandemic, a survey conducted with 1,133 Special Education teachers of Basic Education, in June 2020, concluded that 96.6% were performing activities at home, and of these, 85.7% had no experience in online classes and almost 50% classified their use of digital technology as regular. In this survey, 84.6% of teachers said they had technological equipment available at home, but 55.7% said they needed to share the use of it with others. Of the Special Education teachers 83.6% said that remote classes increased their working hours. The results show that the content was not being adequately learned and 72.5% believe that the content will have to be taught again (Torres & Borges, 2020).

In Brazil, in addition to the direction given by the federation, the states and municipalities also had a great contribution in the normalization and effectiveness of remote learning; for example, the municipality of Vila Velha, in Espírito Santo, approved the Municipal Ordinance no. 009/2020, which implemented a virtual learning platform; the state of Sergipe approved the Ordinance no. 2235/2020/GS/SEDUC, which regulated non-presential school activities; the state of São Paulo approved Decree no. 59.774 of September 17, 2020, which regulated remote activities and their operationalization; the state of Rio de Janeiro approved Law no. 8802/2020, which adopts remote education and provides guidelines; the state of Rio Grande do Sul approved Decree no. 55. 240, of May 10, 2020, which institutes the Controlled Distancing System and the Joint Ordinance no. 01/2020, which provides on the measures to be adopted by all Educational Institutions (Conde et al., 2020; Lei n. 8802, 2020; Decreto n. 55.240, 2020; Portaria Conjunta 01, 2020; Decreto n. 59.774, 2020; Portaria n. 2235/2020/GS/Seduc, 2020).

Despite the several ordinances, decrees and norms of the states and municipalities all provided for remote learning as the only alternative for all levels of education by 2020, there were differences in the platforms made available, in the provision of virtual environments, in the support given to students who had no access to the Internet or equipment, among others. The same prerogatives apply to the target students of Special Education.

Still on the situation of Special Education in Brazil, after a study, Instituto Rodrigo Mendes prepared a Protocol on Inclusive Education during the Covid-19 pandemic (2020). The document gives a warning about the importance of health care and education for special students. It emphasizes as important points the fact that therapeutic and health services for people with disabilities were discontinued, monitoring was difficult to implement for some disabilities, and peer relationships were disrupted (Rodrigo Mendes Institute, 2020). Studies such as by Neta et al. (2020), Silva et al. (2020), Mohan et al. (2020), highlight the importance of therapeutic supports, social interactions, and individualized programs for Special Education students and indicate that remote classes can considerably affect populations that face disadvantages such as Special Education students, as well as the fact that these students have had negative impacts when classes in their schools were suspended. It is also worth mentioning that the Specialized Educational Service, which is the biggest pedagogical support tool for students with disabilities in Brazil, in most states, has encountered many difficulties in becoming effective during remote education activities. There are different reasons, for example, teachers' training on the use of digital technologies, students' access to the Internet and technological equipment, students' ability, the support from their families, among other points (Neta et al., 2020; Silva et al., 2020).

A committee in the field of education in Brazil launched a Covid-19 guide, with guidelines for Special Education from the perspective of inclusion. The guide (available at: https://campanha.org.br/acervo/) is targeted at families, the school community, and government agencies, and aims to provide information and advice on Special Education in the inclusive perspective in the pandemic period and on social distancing. The guide brings together documents, videos, websites, and complementary materials to support the education of people with disabilities.

Special Education and the Pandemic in Canada

The Covid-19 outbreak has caused many challenges of various kinds, such as economic, health, educational, and emotional ones. Numerous studies, e.g., that of Güzel et al. (2020), El-Zraigat and Alshammari (2020), analyzed social, psychological, and emotional situations during isolation and found their negative effects on social and emotional development. The fact of having a disability does not put individuals at risk of contracting Covid-19 nor worsens the disease. What may put a person with a disability at risk is his or her health status. However, the pandemic caused by Covid-19 has increased stress and has been the cause of many psychological problems, and people with disabilities suffer more from social isolation, especially since their social lives are already very restricted (El-Zraigat & Alshammari, 2020).

In March/April 2020, Canada shut down schools and day care centers, among other places, as a measure to prevent the spread of Covid-19. The measure has caused psychological distress in Canadians, including depression and fear. Increased psychological distress impacts people's lives and social relationships (Best et al., 2020).

A Canadian study conducted with 1,381 participants from March 31 to April 15, 2020, a period of social distancing, aimed to identify psychological distress, satisfaction with life, and social connection during the first moments of isolation during the Covid-19 pandemic in Canada. The main results found that the impact was negative, causing psychological distress, especially in the most economically vulnerable people, and that programs should be offered to help these individuals at risk, including targeted activities that could increase socialization, thus creating collective resilience (Best et al., 2020).

Another study involving Canada, the United States, and France compared trends in technology use, the technological environment, and the habits of higher education students, and their respective consequences for distance learning (Wotto, 2020). Methodologically, a systematic literature review was conducted. In all three countries, there was an increase in the number of online platforms, with online courses and accredited systems. In the United States, both public and private institutions argue that technological transformations are the result of many factors and that distance learning after Covid-19 has been shown to be a growing alternative because it creates new spaces. Another aspect perceived in the United States is a great tendency towards internationalization. In France, the national strategy is mainly focused abroad. In Canada, there was a great growth of distance learning and strategies and learning materials and demands were developed in training institutions. The study shows that Distance Learning in Canada is growing; however, Canadian as well as French institutions are expected to update their procedures in the international scenario (Wotto, 2020).

In the Canadian context, education is part of the federal system of shared powers; the constitution provides that each Province and territory can make laws, for example, for Education; they are responsible for organizing education at the elementary, secondary and tertiary levels, along with the ministries of education. Therefore, there are several differences in education policies between the provinces and territories (Government of Canada, 2020).

Of Canada's 37,703,512 inhabitants, four provinces, together, account for approximately 30,500,000 of these inhabitants, namely, Ontario, Quebec, British Columbia, Alberta, which will be particularly addressed in the discussion on Special Education and Covid-19.

In the most densely populated of the provinces and territories, Ontario, primary and secondary schools were closed from March and reopened in November 2020. Classes at universities only returned in September 2021. In view of the shutdown, schools, libraries, and various educational spaces began to operate online (Office of the Premier 2020).

In Ontario, teacher trainers have also been called upon to contribute to solving the challenges posed by the Covid-19 crisis. Internet access rates in Ontario indicate that 12% of Ontario households are underserved or unserved, making it difficult to access remote classrooms. According to Van Nuland et al. (2020), some issues greatly affected learning in remote teaching, e.g., "1) access to effective online connection and support, 2) educator professional development for online learning, 3) conversion of face-to-face courses to successful online courses, and 4) the recognition of student teachers' practical experiences" (p.442).

The closing of schools has had an impact on the learning and school performance of school-age children. In addition to internet access and mastery of technological tools, an important factor is the amount of time a student devotes to instruction. According to Frenette et al. (2020), performance in reading, math, and science is associated with the amount of time a student devotes to them, and those who devote less have worse performance. With schools closed, students who cannot participate in remote learning, regardless of the reason, miss out on many learning activities. Moreover, there is an ongoing debate on the effectiveness of the activities that are offered in this teaching model. In addition, the level of parental involvement in their children's learning activities is an important aspect. Previous studies show that the success of students in the classroom is related to the way parents are involved in learning activities; in the case of remote learning, the role of parents is even more important (Hasler Waters et al., 2014). Therefore, it is not difficult to predict that low-income families, and/or families of children and adolescents with disabilities, owing to their need for different methods and resources, will find it more difficult to cope with remote learning (Frenette et al., 2020).

The second most populous province, Quebec, has an educational policy in which Special Education has a goal of including students with disabilities in the regular classroom. However, among the four districts addressed, Quebec's Special Education policy is the least structured one, with the fewest resources, methods, and supports (Québec, 2006).

The province suspended classes in elementary and secondary schools in March 2020 and reopened them in November 2020, but daycare centers started to be reopened in June 2020. During the shutdown, remote learning was offered, with many digital platforms with activities and guidance for families (Québec, 2021).

According to Russo et al. (2020), since the 1990s, educational inequalities have been increasing in Quebec's educational system. The study found that children who had learning disabilities before the pandemic and students adapting to school were found to be more vulnerable during the pandemic. These students needed extra support, but they were not offered it during the pandemic.

The provinces of British Columbia and Alberta have similar population numbers, in the range of four million. In British Columbia, the Special Education policy is also based on the inclusive perspective. Its documents outline the process of inclusion, assessment, tracking and monitoring, and the support mechanisms that are available (Alberta, 2013; British Columbia, 2017).

With the spread of Covid-19 in the province of British Columbia, daycare centers and schools were closed, but their return occurred sooner than in other districts in Canada. In the first plan to reopen in June 2020, daycare centers for children of essential workers and online classes from Kindergarten to Grade 12 were announced, and the return to face-to-face classes was optional. The return occurred slowly, with limited student numbers and reduced hours (British Columbia, 2021).

A survey carried out with teachers and parents in British Columbia showed that during school shutdowns both teachers and parents felt confused about teaching practices. Both the "learning continuity" at home and the return to the classroom were confusing to the participants. The parents emphasized the school's delay in answering e-mails, and the concern about their children's learning. The families felt overwhelmed and said that the situation was unmanageable on several occasions, but at the same time they affirmed that the fact that their children were at home also brought positive points, for example, it strengthened the bond between parents and children. The teachers, on the other hand, reported missing the group meetings, and increased stress was noted by both groups. The participants also highlighted that they felt deeply concerned when the children had learning difficulties or needed additional educational services (MacDonald & Hill, 2020).

In Alberta, similarly to other districts, children and adolescents with disabilities are included in regular school. There is a legislation in place to regulate and guide how these students can be supported in school (Alberta, 2016). Alberta Education has produced a series of resources that include information and strategies to support the diverse learning needs of children and students in Special Education from Kindergarten to Grade 12 education.

With the pandemic, classes in Alberta were interrupted and remote teaching was adopted. Classes for students from kindergarten to grade 12 had a resumption plan divided into phases, which had specificities as to age, schooling, etc. Classes resumed in June 2020; however, only in September 2020 did the restrictions ease. The precautions were established by the Ministry of Education, and among the many actions was a family orientation guide, i.e., a health checklist that was applied to all students. As for Special Education students, the rules were the same and school authorities were supposed to ensure the full participation and inclusion of students with disabilities when they returned to class, and for those who needed specialized supports and services, plans were to be developed to ensure their inclusion (Alberta, 2020, 2021).

A published case study looked at the experiences of ten parents of children in elementary school programs in Alberta, Canada. The article reports parents' perceptions of homeschooling and the Covid-19 crisis, especially with regard to distance learning and the importance of social interaction. Parental support is an important factor in the education of children. Despite recognizing that parents are very important in children's learning, the pandemic has imposed home education on parents (Fontenelle Tereshchuk, 2021).

In Alberta, as well as across Canada, schools have the inclusive teaching perspective, whose underlying principle is that all children should be in school, regardless of their difficulties or disabilities. Teachers who are qualified to work in Special Education have been prepared for individualized classrooms, and this improves teachers' performance (Fontenelle Tereshchuk, 2021). Since before 2013, teachers in Alberta have been making use of technology for learning (Alberta, 2013), but they were not prepared for the scope of technology use ultimately required during the pandemic.

Finally, the main conclusions are: 1) parents felt tired and even overwhelmed by having the obligation to take care of their children's emotional and academic needs; 2) communication between school and family did not meet all needs; 3) technological difficulties were highlighted by teachers and family members, and the distance learning process made this evident; 4) the curriculum needs to be re-designed to suit distance learning; 5) children being left out of school impacted the mental health of parents and children; 6) school boards and schools did not provide adequate support for teachers and parents; 7) parents believe that, comparatively, remote learning is not as effective as classroom learning; 8) lack of social interaction had negative impacts on children (Fontenelle Tereshchuk, 2021; Shafer et al., 2020).

Conclusions and Implications

Although Covid-19 affected both countries, the conduct adopted in the two countries was different in many respects. An important point to ensure education in times of crisis is legislation. It can be seen that the Special Education legislation in each country and what it could guarantee to students with disabilities was a determining factor in the support that was given to these students during this pandemic period. The more structured the educational system and the Special Education services are, the more chance of success there will be in times of crisis.

Canada, in addition to returning to face-to-face classes earlier, also offered more support for families and students, but as shown by research, it was not enough. Factors such as the type of online platforms, technological availability, user ability, parental supervision, appropriate teaching methodologies for remote learning, balancing the routine, etc. are determining factors for efficient learning in non-face-to-face education.

In Brazil, face-to-face classes have not been resumed yet; most states have not managed to guarantee the Specialized Education Service, which differs from that of Canada, whose documents make it clear that students with disabilities should be guaranteed the return to face-to-face classes in the same way as any other students.

It is a consensus that children with disabilities, under social isolation, were left in a situation of fragility owing to the interruption of school and therapeutic activities, the restriction of interaction with peers, the overload of activities borne by the families, and the absence of solution for the situation.

The studies and legislation under analysis involved different educational issues facing the covid-19 pandemic, and based on the study of the situation of Special Education in the two countries, it can be concluded that in situations of remote education, the following points are important: 1) the choice of tools; 2) quality of Internet connectivity; 3) teachers' and students' knowledge of digital abilities; 4) variation of resources among different platforms, video-classes, printed materials, different methodologies, applications, etc.; 5) recognition of students' psychosocial situation; 6) creation of collective virtual spaces to support students and their families; 7) planning of the teaching program; 8) recognition students' individual needs to offer appropriate support; 8) creation of different means of communication between the school and the family; 9) support to teachers; 10) training on the use of digital tools; 11) monitoring of teaching; 12) combination of different approaches and different media; 13) alternation of synchronous and asynchronous classes; 14) very well-defined rules about the conduction of classes and activities; 15) offer of different types of exercises; 16) offer of feedback to students; 17) attention to the development of students' self-regulation and metacognitive skills; 18) sharing of experiences.

The main limitation of this research is the fact that the search for articles was not carried out in other databases, which otherwise would have benefited from contributions on this topic published by other authors and in other studies.

Regarding contributions, it is noteworthy that the theme is contemporary and therefore there is little research to date. The present study is aimed at collaborating with the growth of theoretical or empirical studies in Brazil and abroad. The findings of the research show what the support strategies were and how interventions were carried out with students with disabilities in both countries. It also made it possible to advance the state of the art in the area by identifying the gaps and challenges posed by this health crisis. The study developed can serve as a basis for other comparative studies, which are extremely necessary in scientific production at a global level.

In a pandemic scenario, one should be more empathetic and supportive, to welcome the differences, to understand the historical, social, political and educational dimensions experienced by people with disabilities. There are still many issues to be researched about Special Education and the demands imposed by the pandemic. This study is expected to encourage the debate on inclusive public policies and on the low supply of services and contribute to the creation of a more just society.

Acknowledgements

The authors have no acknowledgments.

Declaration of Interest

The authors declare no competing interest.

References

Alberta. (2013). *Learning and technology policy framework 2013*. Government of Alberta. https://education.alberta.ca/media/1046/learning-and-technology-policy-framework-web.pdf

Alberta. (2016). *Guide to Education: ECS to Grade 12*. Government of Alberta. http://open.alberta.ca/licence

Alberta (2020). *Covid-19: Education and childcare*. Government of Alberta. https://www.alberta.ca/k-to-12-school-re-entry-2020-21-school-year.aspx

Alberta. (2021). *K-12 learning during Covid-19*. Government of Alberta. https://www.alberta.ca/k-12-learning-during-covid-19.aspx.

Arroio, A. (2020). The value of education in the context of Covid-19 pandemic. *Problems of Education in the 21st Century*, *78*(3), 309-313. https://dx.doi.org/10.33225/pec/20.78.309

Arruda, E. P. (2020). Educação Remota Emergencial: elementos para políticas públicas na educação brasileira em tempos de COVID-19. [Emergency Remote Education: elements for public policies in Brazilian education in Covid-19 times]. *EmRede - Revista De Educação a Distância*, *7*(1), 257-275. https://www.aunirede.org.br/revista/index.php/emrede/article/view/621

Berg, O. A., & Bernd, Z. (2017). Dossiê “Rememorando o Sesquicentenário da Confederação no Canadá (1867-2017)”. [Dossier “Recalling the Sesquicentennial of the Confederation in Canada (1867-2017)”]. *Mouseion*, *27*, 9-12. http://dx.doi.org/10.18316/mouseion.v0i27.3991

Best, L. A., Law, M. A., Roach, S., & Wilbiks, J. M. P. (2020). The Psychological Impact of COVID-19 in Canada: Effects of Social Isolation During the Initial Response. *Canadian Psychology/Psychologie Canadienne*, *62*(1), 143-154. http://dx.doi.org/10.1037/cap0000254

Brazil. (2008). *Política pública de educação especial na perspectiva da educação inclusiva.* [National Policy on Special Education from the Perspective of Inclusive Education]. MEC. http://portal.mec.gov.br/arquivos/pdf/politicaeducespecial.pdf

British Columbia. (2016). Ministry of Education. *Special education services: a manual of policies, procedures and guidelines.* Government of British Columbia. https://www2.gov.bc.ca/assets/gov/education/administration/kindergarten-to-grade-12/inclusive/special_ed_policy_manual.pdf

British Columbia. (2017). *Joint educational planning and support for children and youth in care: cross-ministry guidelines*. Government of British Columbia. https://www2.gov.bc.ca/assets/gov/education/administration/kindergarten-to-grade-12/inclusive/planning-and-support-for-children-youth-in-care.pdf

British Columbia. (2021). Ministry of Education. *About gov.bc.ca*. Government of British Columbia. https://www2.gov.bc.ca/gov/content/about-gov-bc-ca

Conde, P. S., Camizão, A. C., & Victor, S. L. (2020). Pandemia e atividades remotas: possibilidades e desafios para a educação especial. [Pandemic and remote activities: possibilities and challenges of special education]. *Revista Cocar*, *14*(30), 1-16. https://doi.org/10.31792/rc.v14i30

Dantas, T. C. (2017). Vivências de empoderamento e autoadvocacia de pessoas com deficiência: um estudo no Brasil e no Canadá. [Experiences of empowerment and self-advocacy in people with disabilities: A study in Brazil and Canada]. *Educação Unisinos*, *21*(3), 336-344. https://doi.org/10.4013/edu.2017.213.13489

Decreto n. 55.240, de 10 de maio de 2020. (2020, May 10). [Decree no. 55,240, of May 10, 2020]. Institui o Sistema de Distanciamento Controlado para fins de prevenção e de enfrentamento à epidemia causada pelo novo Coronavírus (COVID-19) no âmbito do Estado do Rio Grande do Sul, reitera a declaração de estado de calamidade pública em todo o território estadual e dá outras providências. [Establishes the Controlled Distancing System for the purpose of preventing and fighting the epidemic caused by the new Coronavirus (COVID-19) within the State of Rio Grande do Sul, reiterates the declaration of a state of calamity throughout the national and public territory gives other provisions]. Governo do Estado do Rio Grande do Sul. https://www.legisweb.com.br/legislacao/?id=395059

Decreto n. 59.774, de 17 de setembro de 2020. (2020, September 18). [Decree No. 59,774, of September 17, 2020. Official Gazette of the City, p. 1.]. Regulamenta as atividades de educação durante a pandemia do coronavírus na cidade de São Paulo. [Regulates education activities during the coronavirus pandemic in the city of São Paulo]. Governo da Cidade de São Paulo. http://legislacao.prefeitura.sp.gov.br/leis/decreto-59774-de-17-de-setembro-de-2020/detalhe.

El-Zraigat, I., & Alshammari, M. (2020). The psychological and social effects of Covid-19 outbreak on persons with disabilities. *Canadian Social Science*, *16*(6), 6-13. http://www.cscanada.net/index.php/css/article/view/11758. http://dx.doi.org/10.3968/11758

Fontenelle-Tereshchuk, D. (2021). ‘Homeschooling’ and the Covid-19 crisis: The insights of parents on curriculum and remote learning. *Interchange*, *52*, 167-191.https://doi.org/10.1007/s10780-021-09420-w

Frenette, M., Frank, K., & Deng, Z. (2020). School closures and the online preparedness of children during the Covid-19 Pandemic. *Economic Insights*, *2020001*(103), 1-8. https://eric.ed.gov/?id=ED605398

Government of Canada. (2020). *Community-based measures to mitigate the spread of coronavirus disease (COVID-19) in Canada*. Government of Canada. https://www.canada.ca/en/public-health/services/diseases/2019-novel-coronavirus-infection/health-professionals/public-health-measures-mitigate-COVID-19.html

Güzel, P., Yildiz, K., Esentas, M., & Zerengök, D. (2020). "Know-How" to spend time in home isolation during Covid-19: Restrictions and recreational activities. *International Journal of Psychology and Educational Studies*, *7*(2), 122-131. https://doi.org/10.17220/ijpes.2020.02.011

Han, H. (2018). The current status quo and development of inclusive education in Canada and its enlightenment. *Proceedings of the 4th International Conference on Education Technology, Management and Humanities Science*. Atlantis Press.

Hasler Waters, L., Menchaca, M. P., & Borup, J. (2014). Parental involvement in K-12 online and blended learning. In R. E. Ferdig and K. Kennedy (Eds.), *Handbook of research on K-12 online and blended learning*. ETC Press.

Instituto Brasileiro de Geografia e Estatística (2021). [Brazilian Institute of Geography and Statistics]. Estimativa da população brasileira em 2021. [Estimate of the Brazilian population in 2021]. https://www.ibge.gov.br/

Instituto Nacional de Estudos e Pesquisas Educacionais Anísio Teixeira (2020). [National Institute of Educational Studies and Research Anísio Teixeira]. *Sinopses Estatísticas*. [Statistical Synopsis]. https://www.gov.br/inep/pt-br/acesso-a-informacao/dados-abertos/sinopses-estatisticas.

Kassar, M. C. M., Rebelo, A. S., & Oliveira, R. T. C. (2019). Embates e disputas na política nacional de Educação Especial brasileira [Clashes and disputes in the national policy of Brazilian Special Education]. *Educação e Pesquisa*, *45*, e217170. https://doi.org/10.1590/s1678-4634201945217170

Lei n. 14.040, de 18 de agosto de 2020. (2020, August 18). Estabelece normas educacionais excepcionais a serem adotadas durante o estado de calamidade pública reconhecido pelo Decreto Legislativo n. 6, de 20 de março de 2020; e altera a Lei n. 11.947, de 16 de junho de 2009. [Law nº 14.040 of August 18, 2020 - establishes exceptional educational standards to be adopted during the state of public calamity recognized by Legislative Decree nº 6, of March 20, 2020; and amends Law No. 11,947, of June 16, 2009]. Presidência da República. https://www.in.gov.br/en/web/dou/-/lei-n-14.040-de-18-de-agosto-de-2020-272981525

Lei n. 8802, de 4 de maio de 2020. (2020, May 5). [Law no. 8802, of May 4, 2020]. Autoriza o poder executivo a reduzir a carga horária ou a adotar regime de trabalho remoto para servidores públicos estaduais e trabalhadores terceirizados, na forma que menciona. Governo do Estado do Rio de Janeiro. [It authorizes the executive power to reduce the workload or to adopt a remote work regime for state civil servants and outsourced workers, as mentioned. Rio de Janeiro State Government]. https://pge.rj.gov.br/comum/code/MostrarArquivo.php?C=MTA3NzA%2C

Lingjie, M. A., & Zhanfang, L. I. (2020). China's national image in fighting covid-19 in the eyes of foreign correspondents and foreign medical experts. *Canadian Social Science*, *16*(11), 33-38. http://dx.doi.org/10.3968/11909

MacDonald, M., & Hill, C. (2021). The educational impact of the Covid-19 rapid response on teachers, students, and families: Insights from British Columbia, Canada. *Prospects*, 1-15. https://doi.org/10.1007/s11125-020-09527-5

Martinez, M. C., Cejas, M. N., Alvarez, G. V., Rodriguez, C. P., & Velazco, D. M. (2021). Student perceptions of Ecuadorian virtual platforms during the Covid-19 pandemic. *Problems of Education in the 21st Century*, *79*(2), 241. https://doi.org/10.33225/pec/21.79.241

Medida Provisória n. 934, de 1º de abril de 2020. (2020, April 1). Estabelece normas excepcionais sobre o ano letivo da educação básica e do ensino superior decorrentes das medidas para enfrentamento da situação de emergência de saúde pública de que trata a Lei nº 13.979, de 6 de fevereiro de 2020. [Provisional Measure No. 934, of April 1, 2020a. - Establishes exceptional norms for the academic year of basic education and higher education resulting from the measures to deal with the public health emergency situation referred to in Law No. 13,979, of February 6, 2020]. Presidência da República. https://www.in.gov.br/en/web/dou/-/medida-provisoria-n-934-de-1-de-abril-de-2020-250710591

Mikušková, E. B., & Verešová, M. (2020). Distance education during Covid-19: The perspective of Slovak teachers. *Problems of Education in the 21st Century*, *78*(6), 884-906. https://dx.doi.org/10.33225/pec/20.78.884

Mohan, G., McCoy, S., Carroll, E., Mihut, G., Lyons, S., & Mac Domhnaill, C. (2020). *Learning for all? Second-level education in Ireland during Covid-19*. Esri.

Mustafa, N., Zahoor, H. (2020). Impact of the 2019-20 coronavirus pandemic on education. *International Journal of Health Preferences Research*, 5 (20), 31. https://gavsispanel.gelisim.edu.tr/Document/nmustafa/20201017234635450_cc3c8efd-fc37-48ed-b4b3-48a3f9d758de.pdf

Neta, A. D. S. O., Nascimento, R. D. M., & Falcão, G. M. B. (2020). A educação dos estudantes com deficiência em tempos de pandemia de Covid-19. [The education of students with disabilities in times of the Covid-19 pandemic]. *Interacções*, ***16***(54), 25-48. https://doi.org/10.25755/int.21070

Office of the Premier. (2020). *Ontario extends school and child care closures to fight spread of Covid-19*. News release, March 31. https://news.ontario.ca/opo/en/2020/03/ontario-extendsschool-and-child-care-closures-to-fight-spread-of-COVID-19.html?_ga=2.207124503.565845960.1592056074-1740529241.1592056074

Oleschuk, M. (2020). Gender equity considerations for tenure and promotion during Covid-19. *Canadian Review of Sociology*, *57*(3), 502-515. https://doi.org/10.1111/cars.12295

Ontario. (2017). Policy and Resource Guide. Special Education in Ontario, Kindergarten to Grade 12. Support every child, reach every student. *Government of Ontario*. http://www.edu.gov.on.ca/extra/eng/ppm/ppm.html

Parecer CNE/CP n. 11, de 7 de julho de 2020. (2020, August 3). Orientações Educacionais para a realização de aulas e atividades pedagógicas presenciais e não presenciais no contexto da Pandemia. [CNE/CP Opinion No. 11 of July 7, 2020. Educational Guidelines for the realization of in-person and non-face-to-face classes and pedagogical activities in the context of the Pandemic. National Council of Education]. Conselho Nacional de Educação. Brasília. https://www.semesp.org.br/legislacao/parecer-cne-cp-no-11-2020/

Parecer CNE/CP n. 5, de 28 de abril de 2020. (2020, June 1). Reorganização do Calendário Escolar e da possibilidade de cômputo de atividades não presenciais para fins de cumprimento da carga horária mínima anual, em razão da Pandemia da Covid-19. [National Council of Education. Basic Education Chamber. CNE/CP Opinion No. 5/2020. Reorganization of the school calendar … due to the Covid-19 pandemic. Official Gazette of the Union, Brasília]. Conselho Nacional de Educação. https://normativasconselhos.mec.gov.br/normativa/pdf/CNE_PAR_CNECPN52020.pdf

Portaria Conjunta n. 01, de 02 de junho de 2020. (2020, June 4). [Joint Ordinance no. 01, of June 8, 2020]. Dispõe sobre as medidas de prevenção, monitoramento e controle ao novo coronavírus (COVID-19) a serem adotadas por todas as Instituições de Ensino no âmbito do Estado do Rio Grande do Sul. Governo do Estado do Rio Grande do Sul. [Adjustment on prevention, monitoring and control measures for the new coronavirus (COVID-19) for adoption by all educational institutions in the State of Rio Grande do Sul]. https://www.legisweb.com.br/legislacao/?id=396530

Portaria n. 2235/2020/GS/Seduc, de 27 de maio de 2020. (2020, May 27). [Ordinance No. 2235/2020/GS/Seduc, of May 27, 2020.] Regulamenta, em caráter excepcional, a oferta de Atividades Escolares Não Presenciais a serem desenvolvidas nas Unidades de Ensino da Rede Pública Estadual de Ensino, para cômputo da carga horária mínima anual obrigatória, durante o período de distanciamento social, como forma de conter a disseminação do Novo Coronavírus (COVID-19), e dá providências correlatas. [Exceptionally regulates the offer of Non-Attendance School Activities to be developed in the Teaching Units of the State Public Teaching Network, for the calculation of the mandatory minimum annual workload, during the period of social distancing, as a way to contain the dissemination of New Coronavirus (COVID-19), and takes related measures]. Governo do Estado do Sergipe. https://siae.seduc.se.gov.br/siae.servicefile/api/File/Downloads/aa9e8ddd-035d-4d65-95d9-a59c42a05cc0

Portaria n. 343, de 17 de março de 2020. (2020, March 17). Dispõe sobre a substituição das aulas presenciais por aulas em meios digitais enquanto durar a situação de pandemia do Novo Coronavírus - Covid-19. [Ordinance no. 343, March 17 2020 - provides for the replacement of in-person classes by classes in digital media for the duration of the New Coronavirus - Covid-19 pandemic situation]. http://www.in.gov.br/en/web/dou//portaria-n-343-de-17-de-marco-de-2020-248564376

Québec. (2006). Special education: issues of inclusion and integration in the classroom. *Gouvernement du Québec*. http://www.education.gouv.qc.ca/fileadmin/site_web/documents/ministere/organismes/CELA_Avis_AdaptationScolaire_ANG.pdf

Québec. (2021). Ministère de l'Éducation. *Gouvernement du Québec*. http://www.education.gouv.qc.ca/en/home/

Riegel, A. B., Marques, L. N., & Wuo, A. S. (2021). Legislações que orientam o ensino para educandos com deficiência em tempos de pandemia – Covid-19. [Legislation that guide education for students with disabilities in times of pandemic – COVID-19]. *Revista Humanitaris-B3*, *2*(2), 107-118.

Robson, K. L., Anisef, P., Brown, R. S., & Parekh, G. (2014). The intersectionality of postsecondary pathways: The case of high school students with special education needs. *Canadian Review of Sociology/Revue canadienne de sociologie*, *51*(3), 193-215. https://doi.org/10.1111/cars.12044

Rodrigo Mendes Institute. (2020). *Protocolos sobre educação inclusiva durante a pandemia da Covid-19: um sobrevoo por 23 países e organismos internacionais*. [Protocols on inclusive education during the Covid-19 pandemic: An overflight by 23 countries and international organizations]. Rodrigo Mendes Institute. https://institutorodrigomendes.org.br/wp-content/uploads/2020/07/protocolos-educacao-inclusiva-durante-pandemia.pdf

Russo, K., Oliveira Soares, R., Magnan, M. O., & Borri-Anadon, C. (2020). *Droit à la santé ou droit à l'éducation? Inégalités en éducation pendant la première vague de la Covid-19 au Québec*. [Right to health or right to education? Inequalities in education during the first wave of Covid-19 in Quebec]. Chaire-Réseau de Recherche sur la Jeunesse du Québec. http://obsjeunes.qc.ca/sites/obsjeunes.qc.ca/files/InegalitesCovid.pdf

Santos, E. T., Chavez, E. S., Silva, A. A. M., Lordano, G. A., Ayach, L. R., Anunciação, V. S., & Batista, R. L. (2020). Covid-19 e os impactos na educação: percepções sobre Brasil e Cuba. [Covid-19 and its Educational Implications: Insights Into Brazil and Cuba]. *Hygeia - Revista Brasileira de Geografia Médica e da Saúde*, 450-460. http://dx.doi.org/10.14393/Hygeia0054555

Shafer, K., Scheibling, C., & Milkie, M. A. (2020). The division of domestic labor before and during the Covid-19 pandemic in Canada: Stagnation versus shifts in fathers' contributions. *Canadian Review of Sociology/Revue Canadienne de Sociologie*, *57*(4), 523-549. https://doi.org/10.1111/cars.12315

Silva, K. W., Bins, K. L. G., & Rozek, M. (2020). A educação especial e a Covid-19: aprendizagens em tempos de isolamento social. [Special Education and Covid-19: Learning in times of social isolation]. *Interfaces Científicas-Educação*, *10*(1), 124-136. https://doi.org/10.17564/2316-3828.2020v10n1p124-136

Smith, J. A. (1981). The Education Amendment Act, 1980. *Ottawa Law Review*, *13*, 199-209. https://rdo-olr.org/wp-content/uploads/2018/01/olr_13.1_Smith.pdf

St-Denis, X. (2020). Sociodemographic determinants of occupational risks of exposure to Covid-19 in Canada. *Canadian Review of Sociology/Revue Canadienne de Sociologie*, *57*(3), 399-452. https://doi.org/10.1111/cars.12288

Tan, Q., Lan, Y., & Feng, M. (2016). International comparative study on the curriculum connection between middle and higher vocational education. *Canadian Social Science*, *12*(8), 50-56. http://dx.doi.org/10.3968/8699

Torres, J. P., & Borges, A. A. P. (2020). Educação especial e a Covid-19: o exercício da docência via atividades remotas. [Special education and Covid-19: The exercise of teaching via remote activities]. *Retratos da Escola*, *14*(30), 824-840. http://dx.doi.org/10.22420/rde.v14i30.1205

Unesco. (2020a). *Covid-19: como a Coalizão Global de Educação da Unesco está lidando com a maior interrupção da aprendizagem da história*. [COVID-19: How the UNESCO Global Education Coalition is tackling the biggest learning disruption in history]. Unesco. https://pt.unesco.org/news/covid-19-como-coalizao-global-educacao-da-unesco-esta-lidando-com-maior-interrupcao-da

Unesco. (2020b). *Coronavírus: Unesco e Unicef trabalham para acelerar soluções de aprendizagem a distância*. [COVID-19 UNESCO and UNICEF work to accelerate distance learning solutions]. Unesco. https://nacoesunidas.org/coronavirus-unesco-e-unicef-trabalham-para-acelerar-solucoes-deaprendizagem-a-distancia/

Unesco. (2021). *Resposta à Covid-19*. [Covid-19 response]. Unesco. https://pt.unesco.org/covid19

United Nations Development Programme. UNDP. (2019). *Human Development Report 2019*. Beyond income, beyond averages, beyond today: Inequalities in human development in the 21st century. UNDP. www.undp.org

Van Nuland, S., Mandzuk, D., Tucker Petrick, K., & Cooper, T. (2020). Covid-19 and its effects on teacher education in Ontario: A complex adaptive systems perspective. *Journal of Education for Teaching*, *46*(4), 442-451. https://doi.org/10.1080/02607476.2020.1803050

World Health Organization. (2021). *Coronavirus disease (Covid-19) pandemic*. WHO. https://www.who.int/

Wotto, M. (2020). The future high education distance learning in Canada, the United States, and France: Insights from before Covid-19 secondary data analysis. *Journal of Educational Technology Systems*, *49*(2), 262-281. https://doi.org/10.1177/0047239520940624

Received: *November 20, 2021* Accepted: *January 21, 2022*

Cite as: Givigi, R. C., Jesus, D. M., & Silva, R. S. (2022). Situation of special education in Brazil and Canada during the Covid-19 pandemic. *Problems of Education in the 21st Century*, *80*(1), 162-178. https://doi.org/10.33225/pec/22.80.162

Rosana Carla do Nascimento Givigi *(Corresponding author)*	PhD, Associate Professor at the Speech Therapy Department, Education Graduate Program, Federal University of Sergipe, São Cristóvão, Sergipe, Brazil. E-mail: rosanagivigi@gmail.com ORCID: https://orcid.org/0000-0001-6592-0164
Denise Meyrelles de Jesus	Professor of the Department of Political and Society Education and the Graduate Program in Education – PPGE, Federal University of Espírito Santo (UFES), Vitória – ES, Brazil. E-mail: jesusdenise@hotmail.com ORCID: https://orcid.org/0000-0001-7966-5424
Raquel Souza Silva	MSc, PhD Student of the Education Graduate Program, Federal University of Sergipe, Brazil. E-mail: fgaraquelsouza@gmail.com ORCID: http://orcid.org/0000-0002-6285-0698

This is an open access article under the
Creative Commons Attribution 4.0
International License

TEACHING AND LEARNING MECHANICS EXPLORED THROUGH THE USE OF THE 5E's EDUCATIONAL MODEL

Jean de Dieu Nkurikiyimana, **Jean Uwamahoro, Kizito Ndihokubwayo**
University of Rwanda, Rwanda
E-mail: nkurikiyeja3@gmail.com, mahorojpacis@gmail.com,
ndihokubwayokizito@gmail.com

Abstract

This study assesses the level of application of the 5E's educational model by Rwandan physics teachers and how the model affects the learning of basic classical mechanics in secondary school physics classrooms. For this analysis, quantitative data were collected using the classroom observation tool framed at the 5E's educational model. A sample of six secondary physics teachers was selected purposively from three boarding secondary schools of Nyamasheke district in the western province of Rwanda to participate in this study. Twenty-four classroom observations were conducted during teaching and learning mechanics concepts in the way of four observations for each teacher before being trained on 5E's educational model. This was done to help the researcher to have the real picture of the prior ability of teachers to incorporate 5E's aspects in their usual teaching practices. Similarly, a total of 24 observations were done after teachers' training. The collected data were tabulated in Microsoft Excel, and descriptive statistics were analyzed and presented. The overall mean scores on the teachers' ability to apply 5E's educational model during lesson delivery on introductory mechanics were low before training and increased due to teacher training on the use of 5E's educational model. The main findings from this study revealed that 5E's educational model is more effective in stimulating students' motivation and strong interaction and a better understanding of mechanics concepts through interactive activities, discrepant events, and computer simulations. Based on the findings of this study, some recommendations were suggested that would improve more physics students' active learning.

Keywords: *active learning of mechanics, 5E's educational model, classroom observation, physics students, secondary school, Rwanda*

Introduction

Nowadays, the economic development of societies worldwide is characterized by applications of science in general and physics concepts related to applications in particular. The contributions of Physics knowledge are evident in industries of engineering, transport (automobiles, trains, flights, etc.), medicine, Information and Communication Technology (REB, 2015). Therefore, achieving a technology-led economy requires effective teaching and learning of science and particularly physics. However, the world's development rate is increasing rapidly by applying science and technology that use the principles and fundamental knowledge of physics in all levels of education. Teaching and learning physics worldwide face many challenges. Among them are ineffective teaching approaches used in physics that lead the students to consider physics as an abstract subject that is difficult to learn, hence attracting fewer students than other sciences subjects like chemistry and biology (Fischer & Horstendahl, 1997).

The challenges in teaching and learning physics include inadequate space for lab or lab facilities, insufficient funds for lab materials (Ndihokubwayo, 2017), insufficient library materials, lack of internet service; poor background of the students in mathematics, students'

https://doi.org/10.33225/pec/22.80.179

lower level of thinking capacity, poor English communication, lack of students' interest and motivation to study physics, lack of teachers' competency in their subject, lack of teachers' interest and motivation to be engaged in their professional tasks of conducting experiments and to plan a lesson, and poor method of teaching (Mekonnen, 2014). This leads to students' poor achievement in physics. This aligns with the study conducted by Uwizeyimana et al. (2018), which revealed that the difficulties in teaching and learning physics are closely linked with traditional teacher-centered teaching approaches, commonly used in Rwandan secondary physics classrooms. This method gives teachers all responsibilities for everything taking place in the classroom. At the same time, students are passive listeners of information in the whole period of learning. They are not allowed to express their perceptions, collaborate, and interact with themselves and their teachers; only they respond to teachers' questions (Nzeyimana & Ndihokubwayo, 2019). Additionally, previous educational research indicated that what students learn is highly influenced by the pedagogical teaching methods they are taught (Chadia & Khan, 2019).

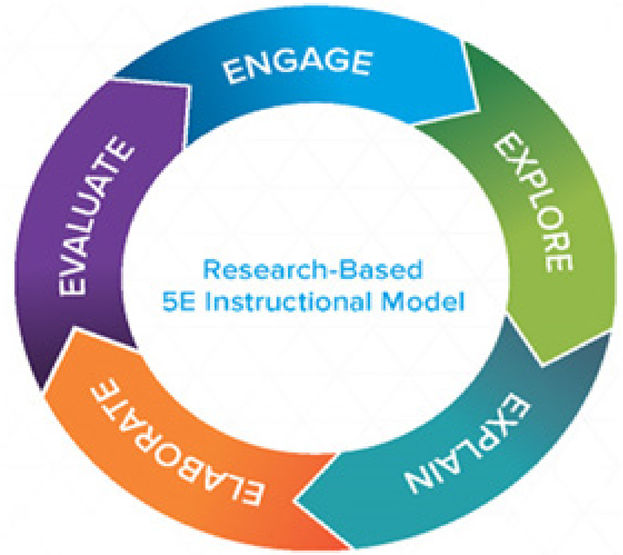
Teaching sciences, including physics, should require the application of different teaching approaches that actively engage students, enable them to work cooperatively to construct knowledge themselves, and avoid the traditional way of memorizing facts as they are written in the documents (Duran & Duran, 2004). Due to that, there is a need for an educational strategy for teaching and learning physics such as 5E's educational model grounded on constructivism that can help both teachers and learners to cope with 21st-century skills. Most developing countries, including Rwanda, have realized the applications of physics in all domains and decided to benefit from it by incorporating active teaching and learning. Active learning is teaching approach that involves the students in the learning process rather than being passive listeners of information from the teacher (Fayombo, 2014).

The recent research studies highlighted the effects of active learning on students' learning, such as: strengthening learning; developing students' thinking skills, communication skills, problem-solving skills; creating curiosity in students; enabling students to apply prior knowledge to a new real-life situation, promoting students' achievement; increasing students' motivation; changing students' attitudes and enabling students to learn more (Aydede & Matyar, 2009; Chadia & Khan, 2019; Karamustafaoglu, 2009).

Inquiry-Based Educational Model

Inquiry-based learning (IBL) is a learner-centered pedagogy that is aimed to increase students' understanding of different subjects, including science subjects. In IBL, students are encouraged to work together as a collaborative team to find out the solution of their questions by themselves throughout the understanding of their learning environment rather than receiving all instructions on what to do, how to do, and when to do from their teacher (Hussain, 2015). The teacher's role in inquiry-based learning is to facilitate learning by helping the students to discover their knowledge rather than being the source of knowledge. Through IBL, the students formulate, investigate, build new understanding based on their preceding understanding, and give meaning to their knowledge (UR-CE, 2020). IBL is one of the teaching approaches that involves active learning in the sciences, and it is a central strategy of all science curricula. For instance, it enhances various learning domains such as students' knowledge, comprehension, application, and skill development. In Indian, inquiry-based science instruction had a positive effect on students' science achievement (Ong et al., 2018). One of the strategies that can help teachers develop inquiry-based lessons is using 5E's educational learning circle approach, which consists of five phases: Engage, Explore, Explain, Elaborate, and Evaluate (Ihejiamaizu, et al., 2018) as Figure 1 illustrates.

Figure 1
The 5E's Educational Model



In the engagement phase, the teachers capture students' attention through exciting activities like telling a story or discrepant events related to the topic, and key questions that attract all students to be curious are formulated. It is aimed to detect students' prior knowledge, interests, and misconceptions about the topic (Alshehri, 2016; UR-CE, 2020). In the exploration phase, teachers provide enough resources and guiding questions to direct learners to do deeper research. Students brainstorm on given questions among their groups to find out the answers corresponding to their curiosity by manipulating provided learning materials. Meanwhile, teachers manage the discussion process and provide clear information on new vocabularies within the groups (Cardak et al., 2008; UR-CE, 2020). In the explanation phase, students are given enough opportunity to present and explain their findings and mention the main ideas on the chalkboard. Teachers interact with students through questions that can make the students' presentation more interesting and constructing and sounding. Meanwhile, the teachers use different techniques, including animations, simulations, and videos, to absorb any misconception that can hinder students' understanding and provide a clear explanation of scientific concepts (Aç et al., 2011; Bybee et al., 2006). In the elaboration phase, learners' understanding is trained with new challenges or daily life situations (Bybee et al., 2006; Duran & Duran, 2004)). In the evaluation phase, the teacher assesses students' progress toward achievement of learning objectives and their teaching approach and provides feedback to the students, which will help them make reasonable decisions on the current lesson (Guzel, 2017).

The 5E's Learning Model and Students' Academic Achievement

Academic achievement can be defined as the extent to which students have attained and met either short or long-term educational goals. It can be represented by completing educational level such as secondary school diploma and at university is represented by bachelor's degree at the university level. The 5E's educational model in teaching and learning sciences, including physics, results in positive effects on students' learning and students' academic achievement. This is supported by the conducted study in Turkey by Açişli et al. (2011), which revealed that the use of the 5E's learning model is more successful and produces good results in comparison with traditional teaching methods. According to the study conducted by Hatice (2017), it aimed to find out the effect of electric current teaching based upon the 5E model on academic achievement and attitudes of students. It has revealed that the students in the experimental group who were taught based on the 5E’s educational model were more successful than the students in the control group. The latter were taught based on the traditional teaching method. Based on the results from this study, it can be said that the lessons taught following the constructivist 5E’s educational models using computer support and other relevant learning materials greatly affect students’ achievement. However, in Turkey, including other countries, it was noticed that it is difficult to teach all lessons using 5E’s model and is inappropriate for all subjects.

The 5Es educational model allows students to be more autonomous in their learning, increases their engagement and interest in science, and improves their learning outcome (Ihejiamaizus et al., 2018) and 5E’s constructivist strategy is more effective than the traditional method when used in a classroom setting. This is in line with the study conducted in Ghana that indicated the significant difference between physics high-ability students in the 5E’s educational group than those in the traditional group (Appiah-Twumasi et al., 2021).

Purpose

According to the study conducted by Hatice (2017), it was found that learners maximized their learning successfully. However, there are not many studies on how 5E’s educational model impacts teaching and learning physics in Rwanda, yet it was found to be more effective for both teachers and students. Therefore, based on the positive effects of 5E’s on both teachers and students highlighted in different research studies, the researchers wanted to evaluate the possible impact of the 5E’s model during the teaching and learning process of physics in Rwandan secondary schools, which is not the case in almost all available pieces of literature. The specific objectives of this study were to assess the current teaching approaches and challenges related to the teaching and learning of physics in secondary schools and evaluate the possible impact of the 5E’s model during the learning and learning process of physics in secondary physics classrooms.

Research Methodology

Focus and Sample

This is a pre/post-observation research design. Quantitative approach was employed to collect and analyze the data. This study was conducted from January to March 2021 in three selected secondary schools, namely: Groupe Scolaire Frank Adamson Kibogora (G.S.F.K); Groupe Scholaire Saint Joseph Nyamasheke (G.S. St Joseph Nyamasheke), and Institut Sainte Famille de Nyamasheke (I.S.F. Nyamasheke) located in Nyamasheke district, the Western Province in Rwanda. It involved six secondary physics teachers, among which three were ordinary level (O-level) secondary teachers, and the other three were Advanced level (A-level) secondary school teachers; all six teachers have a background of education added to their teaching content (physics major). The location of the study, the sample schools, and the teachers were selected purposively because the schools had a wide diversity of combinations with physics as a major subject, and the researcher (first author) has been teaching physics in this district and had previous information about teaching and learning facilities. For instance, four out of six teachers have all graduated from the former Kigali Institute of Education (current University of Rwanda - College of Education, UR-CE). They have been awarded a bachelor's degree in physics with education. The other two who graduated from other institutions have studied for a postgraduate diploma in education (PGDE) offered by UR-CE, qualifying them as professional teachers. Everyone has got a minimum of one training on the Competence-Based Curriculum (CBC).

Instrument and Data Collection Procedure

To collect the data, the researchers, with permission from the district, visited the desired schools and contacted the headteachers and teachers to discuss the study's objectives. The teachers shared their school timetable with the researchers, and the researchers planned classroom observations during a lesson delivery before training on the 5E's educational model. Each teacher was observed four times using a classroom observation tool (see Appendix A) developed by VVOB and UR-CE staff to assess the current teaching approach, the challenges related to physics teaching practices before being trained on the 5Es educational model, and the level of application of the 5E's educational model in teaching (UR-CE, 2021).

The tool (template) was developed for use in the Continuous Professional Development Certificate in Educational Mentoring and Coaching for STEM Teachers (CPD-CEMCMT) (VVOB Rwanda, 2020). This tool has 11 educational aspects divided into three themes of the 5Es model. The first two items or statements are related to the introduction of the lesson, where the teacher excites and engages students. Lesson development is investigated from item-3 to item-9, where students explore, explain, and elaborate on the learning content. Finally, the teacher concludes the lesson by letting students evaluate their learning (covered in item-10 and 11). Each item is coded or evaluated on five scales where “1” means the low occurrence of activity in the item while “5” is when the teacher or students fully do the activity.

After pre-observations, the researchers planned and organized teachers' training. The following activities were covered: discussions, sharing ideas, presentations about 5E's educational model, making lesson plans based on 5Es (see Appendix B), and having teaching sessions for some physics lessons based on 5Es educational model. After being familiar with and having a common understanding of 5E's models, in the same way, the researchers observed each teacher four times after training. A total of forty-eight (48) classroom observations were done so that each teacher's classroom observations before training and after training on the 5E's educational model on related mechanics lessons were conducted within three months (from January up to March 2021).

To ensure the effectiveness and reliability of the research tool, before starting the intervention, the researchers (a team of two observers) read the protocol several times for more understanding and comprehension. Then, the researchers observed a video of a teacher delivering a physics lesson for reliability calculation (as in Ndihokubwayo, et al., 2020). After watching the first video, the researchers found the 0.53 inter-observer reliability coefficients. Researchers watched a second video and found the 0.62 inter-observer's reliability. Lastly, the researchers watched the third video and found 0.72, which is considered high-reliability coefficients. Usually, there are four cut-off points for reliability, which include excellent reliability (0.90 and above), high reliability (0.70-0.90), moderate reliability (0.50-0.70), and low reliability (0.50 and below) (Webb et al., 2006). Appendix B was used as a sample of a lesson plan based on 5E's educational model.

Ethics

Before collecting data, the researchers sought ethical clearance from the unity of research and innovation at UR-CE. The participants were informed and showed the purpose of the study. The research was conducted with respect to ethical values, moral expectations, and rules governing the conduct of research, especially in data collection, such as anonymity and confidentiality of the data.

Data Analysis

To use this tool, the researcher rated on a 5-points Likert scale (from 1: being the lowest to 5: being the highest) the instruction aspect across classroom observation while the teachers delivered the lesson before and after teachers' training on 5E's educational model. Note that the highest score is 5 while the minimum score is 1. For instance, when the item is scored "1" or rated under the first scale, it means the teacher was not observed doing appropriately the activity described under that item. Likewise, it scored 5 or rated under the last scale when a teacher is observed doing everything expected and required described in a certain item (among eleven items of observation tool in Appendix A). The collected data were tabulated in Microsoft Excel 2016 sheets. And a descriptive statistic was used to analyze the mean and standard deviation of the results for both observations before and after teachers' training on the use of 5E's educational model. Thus, since the data were recorded on paper during data collection, the researchers recoded them into spreadsheets after data collection. The data were recorded in a way that the number assigned among five scales of the tool used is horizontally averaged to reveal the average score along each of 11 items.

Research Results

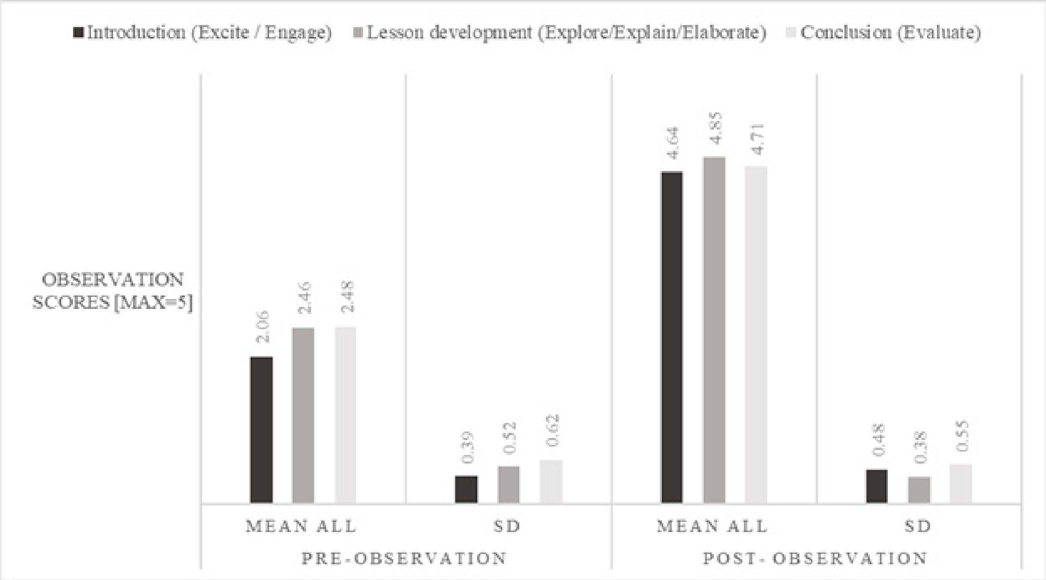
The present study aimed to assess the current teaching approaches and challenges related to the teaching and learning of physics in secondary schools and evaluate the possible impact of using the 5Es model in teaching and learning secondary Physics classrooms. Table 1 presents the means (M) and standard deviations (*SD*) of teacher's ability to apply 5E's educational model before and after training. The average mean score for each item is presented. Thus, the lowest score was found on item-4 (1.96 out of 5) before training, while the highest score was found on item-3 (4.96 out of 5) after training. Generally, it was found that teachers' teaching practice was low (2.39 out of 5); however, after training on 5Es model, they have upgraded their teaching practice drastically (4.79 out of 5) (see Table 1).

Table 1
Comparison of Means (M) and Standard Deviations (SD) of Teacher’s Ability to Apply 5E’s Educational Model Before and After Training

SN	Educational aspects	Pre-observation		Post- observation	
		M	*SD*	*M*	*SD*
Introduction (Excite / Engage)					
1	The teacher introduced with a real material/ story/context/ discrepant event that engages and makes learners excited	2.08	0.41	4.58	0.50
2	The engage/ excite activity leads to formulation of a key question	2.04	0.36	4.71	0.46
Lesson development (Explore/Explain/Elaborate)					
3	New content is explored with a well-chosen real experiment/ video/ animation/diagram(s)/3D model	2.00	0.42	4.96	0.20
4	Demonstration or practical work are didactically well performed	1.96	0.55	4.92	0.28
5	Teacher uses too less/ enough/ too much questioning	2.54	0.51	4.79	0.41
6	Explanation is guided with good visualization	2.54	0.59	4.83	0.38
7	What can be explained by learners is explained by learners and not by teachers	2.46	0.51	4.75	0.53
8	Main ideas are noted on the blackboard and in a notebook	3.00	0.51	4.83	0.38
9	Understanding is trained with new challenges or daily life situations in an elaborate phase	2.75	0.53	4.88	0.45
Conclusion (Evaluate)					
10	Lesson ends with questions in order to repeat/ synthesize/ test understanding of goals/ new knowledge (answer on Key question)	2.58	0.65	4.71	0.55
11	All learners are involved: through using voting techniques, learner activities during group work, assigning roles during group work, etc.	2.38	0.58	4.71	0.55
	Overall	2.39	0.51	4.79	0.43

Figure 2 averages the data presented in table 1. It is a graphical representation that indicates the mean and standard deviation for all teachers about activities across all educational aspects (included in introduction, development, and conclusion) in teaching and learning on four observed lessons delivered before and after teacher training on the 5E’s educational model.

Figure 2
Educational Aspects across All Observed Physics Lessons



Summing up the data obtained in this study that focus on mechanics concepts, the overall mean score, *M*=2.39 out of 5 (corresponding to 47.8%) across all 11 statements of the tool used, was very low due to the teaching approach used. While using the same tool after teachers' training on 5E's educational model, the mean scores were increased up to *M*=4.79 (95%**).** This improvement was made due to the different habit changes of teachers and learners. For example, the improvement of teachers' innovation and creativity during engaging activities, the use of enough improvised resources as well as the use of ICT tools, using high order thinking questions, and ending of a lesson with an evaluation with constructive feedback, allowing the learners to express their findings with confidence, as well as their level of asking questions, and their way of using knowledge to the real-life situations.

Discussion

Before training, the lowest mean score of 1.96 (39.2 %) out of 5 was found at educational aspect 4 (Demonstration or practical work are didactically well performed). This is because most of all teachers that participated in this study did not prepare the practical materials (didactic materials) which can help in the exploration of the lesson of work, like pushing a box on a table which can give the big picture to the learners on the relationship between force, displacement and work; that can help in turn the learners to manipulate tangible surrounding materials in order to enhance their understanding on work concepts. In comparison, the highest mean score of 3.00 (60%) out of 5 was found at the statement 8 (Main ideas are noted on the blackboard and in a notebook). This is because two teachers among the observed ones allowed the learners to present their findings. Their presentations marked the main ideas related to force, work, displacement, energy, and power on the blackboard and discussed them openly.

Almost all visited teachers did not engage the students during the introduction of the lesson. The teachers wrote notes on the chalkboard, and learners copied the notes in their notebooks without understanding. The researchers were expected to observe teachers introducing the lesson of work by using real examples like pushing the wall of the classroom, displacing a table in front of the learners, and asking learners some key questions that will help them understand the concept of work as well as its types. It would be better if the teacher used an example of fetching water by using a jerrican from girls' dormitory to their respective class and asked them some questions that would help them deduce the work formula. This teaching approach neither stimulates nor motivates the students to learn during the lesson development. It could be better if the teachers could introduce the lessons by performing some practical activities or telling a story related to the lesson that engages the students to develop their interest and a positive attitude toward the subject.

During the lesson development, the teachers explained written notes, types of work (positive work, negative work, and zero work), and learners were the guests. Throughout the lesson, the learner's contributions were not considered. This strategy does not address students' needs and interests, which positively affect students' learning and performance (Wieman, & Perkins, 2005). Even it does not produce good results (Hussain, 2015; Madu, 2012). It was expected to find more resources that can be used for deeper exploration, sustain strong discussion among the groups, enough guiding questions for a deeper understanding of work concept and the contribution of teachers in controlling the group discussion, and explicit the new vocabulary within the groups. In addition, the researchers were expecting to observe learners' presentations on the different types of work linked to the general formula and make a product that connects the work concept to the real-life situation.

During the conclusion of the lesson, most teachers did not evaluate the learning objectives of the lesson. While evaluating the lesson's learning objectives is a key aspect that helps the teachers know each student's progress, it motivates the students to learn. It has powerful direct and indirect impacts that are very thoughtful planning and implementation (Ong et al., 2018). In general, during pre-observation, the teaching and learning environment was bored due to the teacher-centered approach. Most of the learners were not interested and were absent minded. Normally, teaching Physics should require a teaching approach that engages learners actively to work cooperatively and construct knowledge themselves instead of the way of memorization (Duran & Duran, 2004; Ndihokubwayo et al., 2021).

After teachers' training on the 5E's educational model, the overall mean score of 4.79 (95%) out of 5 with a standard deviation of 0.40 was obtained across all 11 statements for all six teachers. Teachers were able to prepare an appropriate lesson plan. Ndihokubwayo, Ndayambaje, et al. (2020) presented a thorough model lesson that can be adapted to teachers. During the engaging phase, most of the teachers tried their best to improve their way of creativity and innovation by preparing exciting activities like displacing a desk from one side in the class to another location, singing an interesting song called "work key for life" that grabs most students' attention and curiosity and generating key questions that pull students' involvement in the lesson. This strategy was helpful as long as other learners' talents are also developed. Most of the learners were motivated and curious to know what would be next. In the exploration phase, enough resources were provided and guiding questions to help learners explore deeply. It was an amazing phase where learners were really concentrated on finding the answers to the asked questions, and strong discussion was conducted among the groups and the way the teacher helped each group. During the explanation phase, the presentation was conducted by learners with full confidence to express their ideas with a more energetic voice to convince the rest of the class. It was really an interesting period where learners got an opportunity to explicate the concept of work by using class mopping activity; where learners said that during mopping our class from one corner to another, we applied a certain force, the displacement of water was observed, which described the work done. From this activity, they deduce the formula for work and differentiate different types of work. Such findings were also found when students were exposed to Laboratory activities, YouTube videos, and PhET simulations (Uwamahoro et al., 2021). An interesting product was made in the elaboration phase, where one among the learners came up with a poem on the impact of work in real-life situations. And other groups wrote one page that indicated different situations where different types of work are applied. Reaching the evaluation phase, the teachers provided individual evaluation linked to the learning targets and provided constructive feedback to the learners based on their results obtained through evaluation.

During the conclusion, almost all teachers showed an improvement after teachers' pieces of training as indicated at educational aspects 10 and 11, which had equal mean scores of 4.71 (94.2%) out of 5. This result showed that all teachers get the big picture of evaluation's impact on the teaching and learning process. Therefore, obtaining frequent feedback on your teaching, getting regular insight on student learning plays a central role in decision making (Clipa, 2019).

Conclusions and Recommendations

This study intended to evaluate the teaching and learning mechanics in Rwanda. This was explored through the use of the 5E's educational model. Teachers were observed and found a low level of classroom practice. They were trained in using 5E's model, and the main findings indicated that the use of 5E's educational model is more effective in improving the quality of teaching and learning, fostering and stimulating students' interest in learning, and enhancing the students' ability to understand the concepts of mechanics. Students were engaged in exciting activities, teachers allowed students to explore the learning inputs, and they were able to explain the concepts of mechanics in a fashion way. Teachers gave them opportunity to elaborate more on the learning content and therefore evaluate learning achievement. However, the study was limited in assessing learning through classroom observation. Students' achievement or conceptual understanding were not tested. The researchers recommend educational stakeholders to take into consideration this model and plan teacher training on the use of the 5E's educational model in teaching for all science teachers and distribute enough teaching and learning materials for ensuring the effective implementation of the 5E's educational model in teaching and learning physics. Moreover, the researchers recommend further studies to assess students' performance after implementing this model, cover a large number of schools and teachers about the impact of the 5E' educational model in teaching physics, and use inferential statistics so that the generalization of the findings can be made to the whole country. It is also recommended to research the impact of 5E's model in other science subjects, including chemistry and biology, to generalize the effectiveness of 5E's educational model not only in physics but in all sciences.

Acknowledgment

The researcher would like to appreciate the contribution of VVOB and UR-CE, lectures members for developing the observation tool used in this research while collecting data. The first Author thanks the African Center of Excellence for Innovative Teaching and Learning Mathematics and Science (ACEITLMS) for the full financial support provided while conducting this research.

Declaration of Interest

The authors declare no competing interest.

References

Açışlı, S., Altun, S. Y., & Turgut, Ü. (2011). Effects of the 5E learning model on students' academic achievements in movement and force issues. *Procedia Social and Behavioral Sciences*, *15*, 2459–2462. https://doi.org/10.1016/j.sbspro.2011.04.128

Alshehri, M. A. (2016). The impact of using 5E's instructional model on achievement of mathematics and retention of learning among fifth grade students. *IOSR Journal of Research & Method in Education (IOSR-JRME)*, *6*(2), 43–48. https://doi.org/10.9790/7388-06214348

Appiah-Twumasi, E., Nti, D., Acheampong, R., & Eminah, C. (2021). Effect of the 5E instructional model on physics academic achievement based on gender and students' ability: A case of Berekum senior high schools in Ghana. *East African Journal of Education and Social Sciences*, *2*(1), 1–10. https://doi.org/10.46606/eajess2021v02i01.0060

Aydede, M. N., & Matyar, F. (2009). The effect of active learning approach in science teaching on cognitive level of student achievement. *Journal of Turkish Science Education*, *6*(1), 115–127.

Bybee, R. W., Taylor, J. A., Gardner, A., Van, P., Powell, J. C., Westbrook, A., Landes, N., Spiegel, S., Stuhlsatz, M. M., Ellis, A., Thomas, H., Bloom, M., Moran, R., Getty, S., & Knapp, N. (2006). The BSCS 5E instructional model: Origins and effectiveness. *Colorado Springs, Co: BSCS*, *5*, 88-98.

Cardak, O., M. Dikmenli, M., Sartas, O. (2008). Effect of 5E instructional model in student success in primary school 6th year circulatory system topic. *Asia-Pacific Forum on Science Learning & Teaching*, *9*(2), 1–11. https://www.eduhk.hk/apfslt/download/v9_issue2_files/cardak.pdf

Chadia A.Aji, & Khan, M. J. (2019). The Impact of Active Learning on Students ' Academic Performance. *Open Journal of Social Sciences*, *7*(3), 204–211. https://doi.org/10.4236/jss.2019.73017

Clipa, O. (2019). The impact of evaluation on learning process – teachers perceptions. In *Science Teaching Reconsidered* (Issue August, pp. 1908–1917). https://doi.org/10.15405/epsbs.2019.08.03.235

Duran, L., & Duran, E. (2004). The 5E instructional model: A learning cycle approach for inquiry-based science teaching. *Science Education Review*, *3*(2), 49–58.

Fayombo, G. A. (2014). Active learning strategies and student learning outcomes among some university students in Barbados. *Journal of Educational and Social Research*, *2*(9), 79–79. https://doi.org/10.5901/jesr.2012.v2n9p79

Fischer, H. E., & Horstendahl, M. (1997). Motivation and learning physics. *Research in Science Education*, *27*(3), 411–424. https://doi.org/10.1007/BF02461762

Gutulo, S. G., & Tekello, K. O. (2015). Problems in the teaching and learning of physics in the secondary and preparatory schools, the cases of Wolaita and Dwuro zones. *Global Journal of Human Social Science (G)*, *15*(7), 1–5.

Guzel, H. (2017). The effect of electric current teaching based upon the 5E model on academic achievement and attitudes of students. *Asia-Pacific Forum on Science Learning and Teaching*, *18*(2), 1–21. https://www.eduhk.hk/apfslt/download/v18_issue2_files/guzel.pdf

Hussain, S. (2015). Effect of inquiry teaching method on academic achievements of male students in subject of physics. *European Academic Research*, *2*(12), 15461–15473.

Ihejiamaizu, C. C., Ukor, D. D., & Neji, H. A. (2018). Utilization of 5Es' constructivist approach for enhancing the teaching of difficult concepts in biology. *Global Journal of Educational Research*, *17*(1), 55. https://doi.org/10.4314/gjedr.v17i1.8

Karamustafaoglu, O. (2009). Active learning strategies in physics teaching. *Energy Education Science and Technology Part B: Social and Educational Studies*, *1*(1), 27–50.

Madu, B. C. (2012). Effect of five-step learning cycle model on students' understanding of concepts related to elasticity. *Journal of Education and Practice*, *3*(9), 173–181. https://doi.org/10.1017/CBO9781107415324.004

Mekonnen, S. (2014). Problems challenging the academic performance of physics students in higher governmental institutions in the Case of Arbaminch, Wolayita Sodo, Hawassa and Dilla Universities. *Natural Science*, *06*(05), 362–375. https://doi.org/10.4236/ns.2014.65037

Ndihokubwayo, K. (2017). Investigating the status and barriers of science laboratory activities in Rwandan teacher training colleges towards improvisation practice. *Rwandan Journal of Education*, *4*(1), 47–54.

Ndihokubwayo, K., Ndayambaje, I., & Uwamahoro, J. (2020). Analysis of lesson plans from Rwandan physics teachers. *International Journal of Learning, Teaching and Educational Research*, *19*(12), 1–29. https://doi.org/10.26803/ijlter.19.12.1

Ndihokubwayo, K., Nyirahabimana, P., & Musengimana, T. (2021). Teaching and learning bucket model: Experimented with mechanics baseline test. *European Journal of Educational Research*, *10*(2), 525–536. https://doi.org/10.12973/eu-jer.10.2.525

Ndihokubwayo, K., Uwamahoro, J., & Ndayambaje, I. (2020). Implementation of the competence-based learning in Rwandan physics classrooms: First assessment based on the reformed teaching observation protocol. *EURASIA Journal of Mathematics, Science and Technology Education*, *16*(9), 1–8. https://doi.org/https://doi.org/10.29333/ejmste/8395

Nzeyimana, J. C., & Ndihokubwayo, K. (2019). Teachers' role and learners' responsibility in teaching and learning science and elementary technology in Rwanda. *African Journal of Educational Studies in Mathematics and Sciences*, *15*(2), 1–16. https://www.ajol.info/index.php/ajesms/article/view/188762

REB. (2015). *Advanced level Physics syllabus*. Ministry of Education. https://reb.rw/fileadmin/competence_based_curriculum/syllabi/Upper_Secondary/SCIENCE/Physics_CB_Advanced_Level_Final.pdf

UR-CE. (2020). *Continuous professional Development Certificate in Educational Mentoring and Coaching for STEM Teacher, students manual*. *Volume2: Technological Pedagogical Content Knowledge and Gender in STEM Education*, *Kigali*.

UR-CE. (2021). *Continous Professional Development Certificate in Educational Mentoring and Coaching for STEM Teachers, Student Manual, Module 2: Technological Pedagogical Content Knowledge and Gender in STEM Education (PDM1142), Fourth Edition*.

Uwamahoro, J., Ndihokubwayo, K., Ralph, M., & Ndayambaje, I. (2021). Physics students' conceptual understanding of geometric optics: Revisited analysis. *Journal of Science Education and Technology*, *30*, 706–718. https://doi.org/10.1007/s10956-021-09913-4

Uwizeyimana, D., Yadav, L. L., Musengimana, T., & Uwamahoro, J. (2018). The impact of teaching approaches on effective physics learning: An investigation conducted in five secondary schools in Rusizi District, Rwanda. *Rwandan Journal of Education*, *4*(2), 4–14.

VVOB Rwanda. (2020). Professional learning communities. *A toolkit for school leaders in back-to-school efforts after COVID-19 Closures*, *June*. https://rwanda.vvob.org/download/professional-learning-communities-toolkit-school-leaders-back-school-efforts-after-covid-19

Wieman, C., & Perkins, K. (2005). Transforming physics education. *Physics Today*, *58*(11), 1–13. https://doi.org/https://doi.org/10.1142/9789812813787_0103

Appendix A. The observation guiding tool used to assess the teaching based on the 5Es educational model

	Educational aspects	*1*	*2*	*3*	*4*	*5*
	Introduction (Excite / Engage):					
1	The teacher introduced with a real material/ story/context/ discrepant event that engages and makes learners excited					
2	The engage/ excite activity leads to the formulation of a key question					
	Lesson development (Explore/Explain/Elaborate)					
3	New content is explored with a well-chosen real experiment/ video/ animation/diagram(s)/3D model					
4	A demonstration or practical work are didactically well performed					
5	The teacher uses too less/ enough/ too much questioning					
6	The explanation is guided with good visualization					
7	What can be explained by learners is explained by learners and not by teachers					
8	Main ideas are noted on the blackboard and in a notebook					

9	Understanding is trained with new challenges or daily life situations in an elaborate phase					
	***Conclusion (Evaluate)*:**					
10	The lesson ends with questions in order to repeat/ synthesize/ test understanding of goals/ new knowledge (answer on Key question)					
11	All learners are involved: through using voting techniques, learner activities during group work, assigning roles during group work, etc.					

APPENDIX B. LESSON PLAN ON WORK

School name: …………………………… **Teacher's name**: ……………………………

Term	Date	Subject	Class	Unit N°	Lesson N°	Duration	**Class size**
2	…./…/2021	Physics	S2	8	1 of 4	40 minutes	40

Type of Special Educational Needs to be catered for in this lesson and number of learners in each category	No special education need
Topic area:	Mechanics
Subtopic- area:	Work, power, and energy
Unit title	Work, power, and energy
Key Unit Competence	By the end of this unit, the learner should be able to relate work, power, and energy
Title of the lesson	Work
Educational Objective	By the end of this unit, using simulations, Student's bool, and explanation, the students should be able to:
Knowledge and understanding	Define the term work correctly Recall the knowledge on work clearly.
skills	Analyze the relationship between work and displacement clearly Differentiate various types of works clearly.
Attitudes and values	Appreciate application of work Acquire an analytical mind to critically evaluate work, related issues.
Plan for this Class (location: in / outside)	Inside
Learning Materials (for all learners)	Books, box, table, manila paper, marker, masses, inclined plane and other materials around the classroom
References	Physics learner's book for Rwanda secondary school senior two, page 163 FOUNTAIN PUBLISHERS, www.fountainpublishers.co.ug, Kigali, Rwanda (2017) https://phet.simulation, https://www.ophysics.com/fl.html

Timing for each step	Description of teaching/learning activities		**Generic competences** and **Cross-cutting issues** to be addressed **+ a short explanation Teacher's activities**
	Different activities will be used such as questions and answers, group discussion, learners' explanation observation of some diagrams, pictures, and giving examples and real-life applications.		
	Teacher's activities	**Learner's activities**	
Introduction 5 minutes	**Engage / Excite phase:** The teacher Pulls or pushes a box of chalk on the table and asks some questions to the students What will happen when I push or pull a box? What will happen if you push a box with a small force? What will happen if you push a box with a large force? The teacher writes the key questions of the lesson What is work? What are the necessary conditions for the work to be done? What is the mathematical formula of work? Differentiate three forms of work.	The learners will observe and describe the observations from the teacher's activity and answer the asked questions. The box will move. When you push a box with a small force, the box will not move or move slowly When you push a box with a large force, the box will move.	**GC**: **Communication skills** will be developed through answering questions **CC**: **Inclusive Education** will be catered for throughout the lesson **Gender education** is emphasized through encouraging all learners' regardless sex to participate in the learning and teaching process

	Elaborate phase: The teacher elaborates the lesson by telling a scenario related to the different people doing work. The first person was pushing the wall of the building, the Second was pushing a box of chalks on the smooth surface of the table, and the third person was pulling a cow backward while the cow was still moving forward. Discuss the forms of work done by each person. The teacher tells the students to write their answer on their notebooks so that he/she can mark their answers. **Evaluate:** The teacher summarizes the lesson by providing the definition of work and different forms of energy and mathematical formula of work. The teacher writes an individual evaluation on chalk based on learning objectives. The teacher marks the work done by the students and provides feedback. And answer some questions raised by the students	Students listen to the teacher try to make a correct prediction. They describe and discuss the foam of work done by each person. The first person was doing Zero work because the wall was not moving. The second person was doing positive work because the box was moving in the direction of applied force. The third person was doing negative work because the cow was moving in the opposite direction of the applied force. Listen to the teacher and harmonize their note. Apply their understanding, answer the questions Do the evaluation and submit the answer to the teacher to be marked	**GC:** C**ritical thinking skills will be developed** while students explore the phenomena and reflect on teacher's questions **Cooperation** will be developed through working together performing experiment **CC** **Financial Education** Will be discussed to show that the income is proportional to the work done. GC: **Interpersonal relations and life skills** will be developed through challenging each other; therefore, this will promote the development of the higher-order thinking skills **Lifelong learning** will be developed via contextualizing the learned concept
Self-evaluation			

Received: *October 14, 2021* Accepted: *January 29, 2022*

Cite as: Nkurikiyimana, J. D., Uwamahoro, J., & Ndihokubwayo, K. (2022). Teaching and learning mechanics explored through the use of the 2 5E's educational model. *Problems of Education in the 21st Century*, *80*(1), 179-194. https://doi.org/10.33225/pec/22.80.179

Jean de Dieu Nkurikiyimana *(Corresponding author)*	Bachelor of Education (Hons) Physics (Secondary), Master student at African Center of Excellence for Innovative Teaching and Learning Mathematics and Science (ACEITLMS), University of Rwanda College of Education (URCE), Kayonza, P.O Box 55 Rwamagana, Rwanda. E-mail: nkurikiyeja3@gmail.com ORCID: https://orcid.org/0000-0002-4020-031X
Jean Uwamahoro	Associate Professor of Physics at University of Rwanda College of Education (URCE), Kayonza, P.O Box 55 Rwamagana,, Rwanda. E-mail: mahorojpacis@gmail.com ORCID: https://orcid.org/0000-0002-1730-6685
Kizito Ndihokubwayo	PhD, Researcher, African Center of Excellence for Innovative Teaching and Learning Mathematics and Science (ACEITLMS), University of Rwanda College of Education (URCE), Kayonza, P.O Box 55 Rwamagana, Rwanda. E-mail: ndihokubwayokizito@gmail.com ORCID: https://orcid.org/0000-0002-2566-8045

This is an open access article under the
**Creative Commons Attribution 4.0
International License**

EVALUATION OF DISTANCE EDUCATION PROCESS IN SPORTS HIGHER EDUCATION

Uğur Özer
Hitit University, Turkey
E-mail: ugurozer84@hotmail.com

Abstract

In present conditions, where distance education applications in higher education have become widespread due to the Covid-19 pandemic, it is seen in the research studies that the satisfaction levels of the lecturers and students are low. Although the developments in information technologies have reached advanced dimensions, the problems experienced in distance education systems have negatively affected the course functioning of the educators and the students' level of participation in the course. The issues experienced led the researchers to studies in which in-depth analysis of distance education applications was carried out. This study aims to evaluate the distance education applications in sports higher education. This research follows a case-study design, with a qualitative study model applied in terms of the techniques used to analyse the data obtained. The descriptive analysis method was taken as the basis of the study. As a qualitative research tool in the study, a semi-structured interview form was used by choosing the interview technique. The research study group consisted of fourteen academicians working in universities in Turkey, selected by criterion sampling, one of the purposeful sampling methods. The data obtained from the interviews were analysed in the MAXQDA 20 qualitative data analysis program. As a result of the study, it was emphasized that distance education in sports sciences should be designed and implemented according to the targeted outputs of the field-specific courses and the students' accessibility to distance education.

Keywords: *distance education, sports higher education, case study, MAXQDA*

Introduction

Today, distance education applications emerge as a rapidly growing sector worldwide. Distance education is now an accepted part of general education (Raymond, 2005). Especially with the unprecedented outbreak of the COVID-19 pandemic, distance education applications in higher education have come to the fore worldwide (Hiep-Hung & Tien-Thi-Hanh, 2020). Although the developments in information technologies have reached advanced dimensions since the first distance education applications were carried out, the effectiveness and efficiency of this education model are questioned in the research studies.

Caleb Phillips announced the first known distance education application in history in the Boston Newspaper on March 20, 1728. In the advertisement, Caleb Phillips stated that he could teach this art to those living in any part of the country who want to learn shorthand, as he would teach someone living in his city (Holmberg, 2008). However, it is not known precisely how this training took place. Nearly a hundred years later, we find more conclusive evidence of distance education. Lund's Weckoblad No. 1833, published weekly in the Swedish city of Lund. In 30, an advertiser offered training by mail to those wishing to work on composition (Holmberg, 2008). In 1840, Isaac Pitman received permission to teach shorthair by mail in the newly established England (Simonson et al., 2015). It will not be difficult to understand how difficult it was to realize open and distance education with the postal service at that time compared to today.

ISSN 1822-7864 (Print) ISSN 2538-7111 (Online)
https://doi.org/10.33225/pec/22.80.195

Distance education, which started its adventure with learning by correspondence, developed over time and gained a different dimension. Researchers and practitioners interested in distance education, telephone, radio, television, computer, internet, etc. they reasoned about how to use all new communication tools to increase the quality of distance education. As a result, they put forward the types, definitions, and theories of distance education (Yılmaz & Karataş, 2020).

Distance education is a teaching model in which teaching and learning are carried out separately from each other. Communication between teacher and student is provided through print, electronic, mechanical, or other devices, including applications to be carried out in face-to-face education (Moore, 1973).

According to Wedemeyer (1981), who studied non-traditional learning methods, distance education describes learning activities where the learner and the teacher are physically far from each other. Besides these definitions, the key elements of distance education can be listed as follows (Yılmaz & Karataş, 2020):

- What makes distance education different from face-to-face education is the physical separation of the lecturer and the student.
- The point separating distance education from self-studying is that the education is carried out through an institution.
- Technical tools are often used to bring together the educator and the student and deliver the educational content to the student.
- Two-way communication is provided so that the student can benefit from and even initiate the dialogue.
- There is the opportunity to meet when necessary for both didactic and social purposes.

Based on the definitions, trainer, student, and distance education technology can be counted as the essential elements of distance education. The main thing here is that the lecturer and the student are in different places, and distance education occurs through an educational institution. Information technologies, computer hardware systems, and communication tools support education professionals in distance education (Shih et al., 2007).

Distance education nowadays almost entirely refers to online learning, in which teachers and students can be located anywhere, and the learning process can be synchronous or asynchronous. Not simply distant learning, but learning itself, is transformed by the digital age (Altany, 2009).

Today, with the developments in information and communication technologies, time and space limits in education have disappeared, and distance education service has become widespread throughout the world (Ferruci et al., 2009, Kırık, 2014). The aim of the developing and widespread distance education; is to provide education and training opportunities to people with systems that can keep up with the developing technology and contribute to human education without being affected by time and space by removing the time and geographical barriers that disrupt education (Özbay, 2015). Today senior executives across the industry are increasingly seeing online and blended learning as crucial to their long-term strategy, and indeed their survival (Naidu, 2021). With vast global consequences, distance education has taken on new life and significance. Given the global epidemic and the accompanying radical and thorough adjustments to online education, it appears that distance learning will only continue to grow (Mellieon & Robinson, 2021). Therefore, research in this field will contribute to the formation of universal distance education applications and support the use of technology most effectively and efficiently. In this respect, it is expected that this research will contribute to distance education literature. The study focused on the following questions:

1. What are the thoughts of the lecturers about the distance education practices in sports higher education during the pandemic process?

2. What are the advantages and disadvantages of distance education applications in sports higher education during the pandemic process?
3. What are the challenges of distance education applications in sports higher education during the pandemic process?
4. What are the views of the lecturers on the management of the education system during the pandemic process?
5. What are the factors affecting distance education?

Research Problem and Research Aim

The Covid-19 pandemic, which emerged at the end of 2019, affected the whole world in a short time and became the beginning of a complete change in people's lifestyles, priorities, and perspectives on life. This beginning made it necessary for many institutions and sectors to renew themselves (Doğan & Zorkol, 2021).

One of the areas most affected by the Covid-19 pandemic has been the education sector. In this process, it was aimed to ensure the continuation of education without interruption for all countries where the pandemic was seen (Can, 2020), and it accepted that the best method to prevent contagion in the field of education is distance education applications (Yamamoto & Altun, 2020). With the transition to distance education, educational institutions that lacked a ready infrastructure experienced various difficulties and negativities. There are two primary aims of this study: 1. To evaluate the distance education applications that have been put into practice with the Covid-19 pandemic in higher education institutions providing sports education in Turkey. 2. To offer suggestions for the development of distance education applications.

Research Methodology

Research Model

The descriptive analysis approach was utilized as the basis for this case study, which used a qualitative study model in terms of the tools used to examine the data acquired. According to the descriptive analysis approach, the information gathered is compiled and evaluated based on the previously established topics. The data can be sorted into themes based on the study questions. It might be presented by thinking about the questions or dimensions asked during the interview and observation phases. Direct quotations are regularly used in descriptive analysis to reflect the viewpoints of the individuals interviewed or observed. This type of analysis aims to deliver the findings to the reader logically and understandably. The data obtained for this purpose are first described systematically and explicitly. These descriptions are explained and evaluated, cause-and-effect correlations are investigated, and conclusions are drawn (Yıldırım & Şimşek, 2016). The planning, design, data collection, analysis, and interpretation of the research were carried out between December 2020 and November 2021.

Ethical Considerations

Before asking the opinions of the participants, the purpose, structure and duration of the research were stated. In addition, it was stated that participation in the research was completely voluntary, that they could refuse to participate in the study, that their opinions would be used for purely scientific purposes, and their identity information would be kept completely confidential, and voluntary participation consent was requested.

Participants

The research study group consisted of lecturers from the sports field, who were selected by criterion sampling, one of the purposeful sampling methods. The basic understanding in the criterion sampling method is to study the situations that meet a set of predetermined criteria (Yıldırım & Şimşek, 2016). The research sample was determined by the criterion of teaching over distance education systems in sports sciences. Accordingly, 14 lecturers who met the research criteria could be reached and their opinions.

Table 1
Data on Participants

Participants	Age	Gender	Title	Department	University
P1	35	Male	Assistant Prof.	Physical Education and Sports Teaching	Erzincan Binali Yıldırım
P2	30	Female	Lecturer	Sports Management	Hitit
P3	34	Female	Assoc. Prof.	Coaching Education	Gazi
P4	29	Female	Lecturer	Physical Education and Sports Teaching	Hitit
P5	33	Male	Lecturer	Sports Management	Hitit
P6	37	Female	Assistant Prof.	Coaching Education	Atatürk
P7	35	Female	Assoc. Prof.	Recreation	Kırıkkale
P8	37	Male	Assistant Prof.	Sports Management	Tokat Gaziosmanpaşa
P9	43	Male	Lecturer	Coaching Education	Yozgat Bozok
P10	39	Male	Lecturer	Coaching Education	Ankara
P11	34	Male	Lecturer	Coaching Education	Hitit
P12	37	Male	Assistant Prof.	Sports Management	Hitit
P13	39	Male	Lecturer	Sports Management	Artvin Coruh
P14	37	Male	Lecturer	Sports Management	Artvin Coruh

Table 1 shows the departments where the lecturers interviewed within the scope of the research work in Turkey. According to these data, six interviewees from the sports management department, five from the coaching education department, two from the physical education teaching department, and one from the recreation department were interviewed. Universities where the participants work; Hitit University (5), Artvin Coruh University (2), Gazi University (1), Ankara University (1), Atatürk University (1), Erzincan Binali Yıldırım University (1), Yozgat Bozok University (1), Tokat Gaziosmanpaşa University (1), Kırıkkale University (1).

Data Collection and Analysis

In the study, since it is the shortest way (Yurdakul, 2013) to learn individuals' knowledge, thoughts, attitudes, and behaviours on various subjects and their possible causes, the interview technique was preferred as a qualitative research tool and a semi-structured interview form was used. While preparing the semi-structured interview form used within the scope of the study, the following stages were passed:

- A literature review related to the study area was done.
- Within the framework of the conceptual information obtained from the literature review, questions were formed for the study.
- The questions created were submitted to examine two academicians, who are experts on the research subject, and their opinions were taken.
- Interviews were held on the internet with the interview form containing the following questions, giving their final shape.

1. What is your general opinion about distance education?
2. What are the advantages of distance education over face-to-face education, in your opinion?
3. What are the disadvantages of distance education over face-to-face education, in your opinion?
4. What are the challenges you face when it comes to distance learning?
5. What are your thoughts on the management of the education system in the current period?

Data Analysis

Two experts analysed the data obtained from the interviews with the participants in the field with the descriptive analysis method. The descriptive analysis process, which was carried out using the MAXQDA 20 qualitative data analysis program, consisted of the following stages (Yıldırım & Şimşek, 2016):

- Creating a framework for descriptive analysis,
- Data processing following the theme framework,
- Findings identification,
- Findings interpretation.

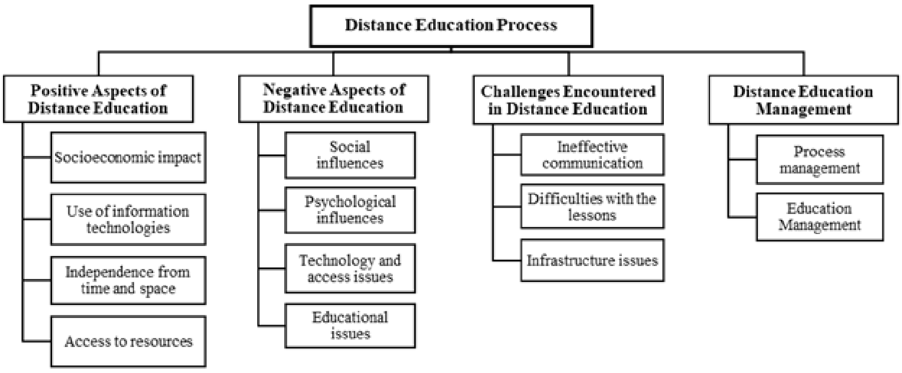
Similar codes obtained as a result of the descriptive analysis made by the coders were determined as agreements, and different codes were determined as disagreement. The reliability calculation of the findings obtained due to the descriptive analysis was 82% with the formula "reliability = number of agreements / total number of agreements + disagreements x 100" suggested by Miles and Huberman (1994). According to Miles and Huberman (1994), rates above 70% are considered reliable.

Research Results

When Figure 1 is examined, as a result of the analysis of the data obtained in line with the opinions of the lecturers, 4 themes were created.

Figure 1

Themes and Sub-themes Related to the Process of Distance Education


Distance Education Process
Positive Aspects of Distance Education
Socioeconomic impact
Use of information technologies
Independence from time and space
Access to resources
Negative Aspects of Distance Education
Social influences
Psychological influences
Technology and access issues
Educational issues
Challenges Encountered in Distance Education
Ineffective communication
Difficulties with the lessons
Infrastructure issues
Distance Education Management
Process management
Education Management

These themes were: ‘Positive aspects of distance education‘, ‘Negative aspects of distance education‘, ‘Challenges encountered in distance education‘, and ‘Distance education management‘, and 13 sub-themes depending on these themes.

Table 2

Data on the Theme of Positive Aspects of Distance Education

Sub-theme	Codes	Example Expressions
Socioeconomic impact (*f*=5, 13.89%)	Reducing the spread of the pandemic (*f*=2, 5.56%)	*“In my opinion, the only positive side of distance education compared to formal education is its contribution to preventing the spread of the worldwide epidemic we are in.” (P11)*
	Economic (*f*=3, 8.33%)	*“With the participation of the students from their own homes, they go to their schools in different cities and provide accommodation, food, transportation, etc. contributes to their economy by preventing them from making expenses.” (P12)*
Use of information technologies (*f*=7, 19.44%)	Instructional diversity (*f*=3, 8.33%)	*“With different teaching methods that can be used in distance education, students' commitment to the curriculum can be increased.” (P14)*
	Technological possibilities (*f*=4, 11.11%)	*“…On the other hand, I think it is positive in terms of encouraging students and teachers to use technology in lessons.” (P10)* *“In fact, I think it is a positive process for both educators and students to learn information Technologies.” (P13)*
Independence from time and space (*f*=13, 36.11%)	No time limit (*f*=7, 19.44%)	*“It allows 24/7 access to the educational environment of students from any location with internet connectivity, regardless of time or location.” (P2)* *“…another benefit is that it provides flexibility in course hours.” (P5)*
	No space limit (*f*=6, 16.67%)	*“…In addition, I think it is useful for the student to reach from anywhere.” (P9)* *“The fact that all participants can attend the classes from wherever they want is an important advantage in terms of money, time and comfort.” (P10)*
Access to resources (*f*=11, 30.56%)	Lesson repetition (*f*=6, 16.67%)	*“The ability of students to manage their own productivity levels thanks to fast access to online resources, easy sharing and course repetitions.” (P3)* *“…if the lectures are recorded as videos and shared with the students, they can be watched over and over again.” (P5)*
	Source diversity (*f*=3, 8.33%)	*“I was able to use various educational materials more effectively (videos, YouTube, congresses, seminars). It is very nice to be able to use many different materials on technical and theoretical subjects.” (P7)*
	Access to information (*f*=2, 5.56%)	*“…Possibility of teaching lessons with technological tools and the possibility of accessing information quickly and easily constitute its positive aspects.” (P6)*

Table 2 shows four sub-themes and nine codes related to the theme of ‘Positive aspects of distance education‘. The codes were created according to 36 different views. According to these data, the sub-theme ‘Socioeconomic impact‘ (*f*=5) constituted 13.89% of the total opinions (*f*=36), the sub-theme ‘Use of information technologies‘ (*f*=7) constituted 19.44% of the total opinions (*f*=36), The ‘Independence from time and place‘ sub-theme (*f*=13) constitutes 36.11% of the total opinions (*f*=36), and the ‘Access to resources‘ sub-theme (*f*=11) constitutes 30.56% of the total opinions (*f*=36). The “No time limit” has the highest rate (*f*=7) among the codes, with 19.44%. Accordingly, both students and educators have a wider time interval for teaching than face-to-face education. In addition, it was emphasized that students and educators could attend classes from places they are outside of school, with the code “No space limit” (*f*=6, 16.67%). The “Lesson repetition” code (*f*=6, 16.67%) means that students can repeat the courses taught and recorded in the system whenever they wish. In other codes created, it was emphasized that the positive effects of technology on education processes, students can easily access various educational resources and information in digital environments, the distance education process is more economical for students than face-to-face education, and the process is important in terms of reducing the spread of the pandemic.

Table 3
Data on the Theme of Negative Aspects of Distance Education

Sub-theme	Codes	Example Expressions
Social influences (*f*=18, 29.52%)	Socialization (*f*=2, 3.28%)	*“Students cannot get the chance to socialize by staying away from the classroom and friend environment.” (P12)*
	Inequality of opportunity (*f*=4, 6.56 %)	*I do not think that distance education can be efficient unless equal conditions are created for every student.” (P4)* *“Since not every student has the same minimum requirements, the lack of equality in education is the most important negative aspect of when comparing distance education to face-to-face education.” (P5)*
	Communication issues (*f*=6, 9.84%)	*“In distance education, it is not possible to interact with the student as in face-to-face education. Questions asked often go unanswered.” (P12)* *“The lack of direct interaction between the student and the teacher, the communication problem...” (P6)*
	Participation issues (*f*=6, 9.84%)	*“Not all students can attend the class at the designated time.” (P14)* *“It is very difficult to ensure that the student participates in the lesson online.” (P5)*
Psychological influences (*f*=15, 24.59%)	Motivation issues (*f*=10, 16.39%)	*“Students have motivation problems …” (P8)* *“The biggest challenge of this process has been the adaptation problem.” (P9)*
	Educator indifference (*f*=2, 3.28%)	*“Some of our colleagues have caused the student's interest in the lesson to decrease.” (P6)*
	Student apathy (*f*=3, 4.92%)	*“The presence of educators and students who do not care about the process creates a different negative situation …” (P13)*
Technology and access issues (*f*=13, 21.31%)	Lack of equipment (*f*=5, 8.2%)	*“Another problem is that students do not have the necessary tools to participate in the lesson …” (P4)*
	Access issues (*f*=8, 13.11%)	*“Access to education was disrupted for students with insufficient internet infrastructure.” (P6)* *“…access to classes is a big problem for both us and students.” (G2)*
Educational issues (*f*=15, 24.59%)	Ineffective training (*f*=2, 3.28%)	*“I believe that the student's active engagement in the class is not being realized. In addition, although the lecturer can reach the student at the teaching point, he cannot reach the student at the training point.” (P10)*
	Exam abuse (*f*=2, 3.28%)	*“…The fact that students cheat during the process and this situation cannot be prevented creates negativity.” (P13)*
	Theoretical lessons (*f*=2, 3.28%)	*“Although theoretical lessons are given with synchronous training, I think that these are not efficient enough.” (P12)*
	Applied lessons (*f*=9, 14.75%)	*“The system is not suitable for providing sufficient education for the field of sports sciences... Necessary opportunities for practice courses are not provided.” (P8)* *“The most important problem is inability to conduct practical lessons.” (P12)*

Table 3 shows four sub-themes and 13 codes related to the “Negative aspects of distance education” theme. The codes were created according to 61 different views. According to these data, the “Social influences” sub-theme (*f*=18) constituted 29.52% of the total opinions (*f*=61), the “Psychological influences” sub-theme (*f*=15) constituted 24.59% of the total opinions (*f*=61), “Technology and access issues” sub-theme (*f*=13) constitutes 21.31% of the total opinions (*f*=61), and the “Educational issues” sub-theme (*f*=15) constitutes 24.59% of the total opinions (*f*=61). The “Motivation issues” code has the highest rate (*f*=10) with 16.39% among the codes. Accordingly, the motivation problem experienced by educators and students in the distance education process was emphasized. “Applied lessons” code (*f*=9, 14.75) has been a frequently expressed code because applied sports lessons cannot be processed properly in the distance education process. “Access issues” code (*f*=8, 13.11%) was determined as another code that expresses the problems related to internet access problems experienced by both students and educators. With the “Participation issues” code (*f*=6, 9.84%), the educators stated that they sometimes had problems with the participation of the students in the education module. The “Communication issues” code (*f*=6, 9.84%) was created based on the statement that the educator and the student could not establish healthy communication during distance education. Another important issue emphasized by the educators is the “Lack of equipment” (*f*=5, 8.2%) code, which was created because students stated that they did not have the necessary equipment for distance education. In the other codes created, it was emphasized that there is inequality of opportunity because not every student has the minimum requirements, that some students and educators are indifferent, that even the theoretical lessons cannot be taught efficiently enough, that there may be abuse in the exams by cheating, that the students are kept away from the social education environment and that education cannot be provided effectively.

Table 4
Data on the Theme of Challenges Encountered in Distance Education

Sub-theme	Codes	Example Expressions
Ineffective communication (*f*=5, 16.13%)	Disinterested students (*f*=2, 6.45%)	*“Trying to increase student interest in the lesson is the biggest challenge.” (P11)*
	Miscommunication (*f*=3, 9.68%)	*“I do not have difficulties in communicating with the student and in reaching the students …” (P4)*
Difficulties with the lessons (*f*=10, 32.25%)	Lesson process (*f*=2, 6.45%)	*“…In this sense, teaching efficiency and teaching diversity of a teacher who tries to teach the lesson in face-to-face lessons in the form of questions and answers decreases” (P10)*
	Lesson intensity (*f*=2, 6.45%)	*“Because of my intensive classes (15 lessons), I cannot get up from the computer. It is difficult to make a promise to the student, so it is very tiring to simply talk for 1 hour and 30 minutes without a break” (P7)*
	Difficulty in assessment and evaluation (*f*=6, 19.35%)	*“In distance education, it is extremely difficult to properly develop a measuring and evaluation system.” (P5)* *“We do not have a good system in terms of assessment and evaluation.” (P7)*
Infrastructure issues (*f*=16, 51.61%)	Insufficient infrastructure (*f*=4, 12.9%)	*“The problem is that educational institutions do not have the infrastructure to provide distance education.” (P13)*
	Failure to meet minimum requirements (*f*=3, 9.68%)	*“Failure to meet the minimum requirements for the conduct of the courses is an important deficiency” (P1)*
	Connection issues (*f*=6, 19.35%)	*“Inability to connect to the system caused by the internet infrastructure and disconnection during the lesson…” (P4)* *“First of all, I have internet connection problems because the place where I live is in the countryside.” (P2)*
	Education platform issues (*f*=3, 9.68%)	*“The problem is that the interfaces of distance education systems are not user-friendly.” (P10)*

Table 4 shows three sub-themes and nine codes related to the theme of "Challenges encountered in distance education". The codes were created according to 31 different views. According to these data, the sub-theme "Ineffective communication" (*f*=5) constituted 16.13% of the total opinions (*f*=31), the sub-theme "Difficulties with the lessons" (*f*=10) constituted 32.25% of the total opinions (*f*=31), The sub-theme of "Infrastructure issues" (*f*=16) constitutes "51.61% of the total opinions (*f*=31). "Connection issues" and "Difficulty in assessment and evaluation" (*f*=6, 19.35%) codes have the highest rate among the codes. While the "Connection issues" code indicates connection problems originating from the internet infrastructure, the "Difficulty in assessment and evaluation" code refers to the difficulties associated with students' exam practices and their assessment and grading. With the code "insufficient infrastructure", it was stated that sufficient infrastructure for distance education could not be fully established in educational institutions. In the other codes created, it was emphasized that the minimum requirements for the conduct of the courses were not met, the problems related to the use of distance education modules, the difficulty in communicating with the students, the ineffectiveness of the courses, the complaints of some educators about the intensity of the courses, and the indifference of the students to the courses.

Table 5
Data on the Theme of Distance Education Management

Sub-theme	Codes	Example Expressions
Process management (*f*=24, 66.67%)	Distance education process (*f*=11, 30.56%)	*"Distance education is a practical training opportunity for situations where people's educational institutions must be closed, such as global diseases or natural disasters" (P14)* *"In general, I think we failed in the distance education process." (P4)* *"The conditions we are in have necessitated the distance education process." (P5)*
	Management follow-up (*f*=2, 5.56%)	*"I don't find it ethical that the top management should interfere in the lessons so much and that the lecturers should prepare reports on what they are doing." (P1)*
	In-service training (*f*=3, 8.33%)	*"The biggest shortcoming of our university in this process is that it does not adequately train academics …" (P11)*
	Process applications (*f*=5, 13.89%)	*"I believe that the process of online education is poorly managed. In this process, the Council of Higher Education avoided taking responsibility and left the decisions to the universities, universities waited for the departments and departments for the teachers to make decisions. As a result, no decision could be taken properly, and unity could not be achieved." (P12)* *"Although there are problems in terms of process applications, I think that distance education is necessary in the current situation." (P10)*
	Crisis management (*f*=3, 8.33%)	*"In my opinion, it was a complete crisis process and both the pre-crisis period, and the ongoing practices reveal that the crisis process was not managed properly." (P13)*
Education management (*f*=12, 33.33%)	Synchronous training (*f*=3, 8.33%)	*"Synchronous training is healthier than asynchronous training. Because you can get instant feedback." (P1)*
	Education system (*f*=2, 5.56%)	*"In my opinion, our education system is wasting our time imagining that with a magic wand this epidemic will end, and we will go back to the old days as if nothing had happened." (P13)*
	Education platform (*f*=7, 19.44%)	*"It is an important indicator for the next process that especially higher education institutions increase their distance education infrastructure to a certain level in a short time." (P10)* *"Distance education platforms have technical inadequacies. I think it will get better over time." (P6)*

Table 5 shows two sub-themes and eight codes related to the “Distance education management” theme. The codes were created according to 36 different views. According to these data, the “Process Management” sub-theme (*f*=24) constitutes 66.67% of the total opinions (*f*=31), and the “Education management” sub-theme (*f*=12) constitutes 33.33% of the total opinions (*f*=31). The code “Distance education process” (*f*=11, 30.56%) has the highest rate. The “distance education process” code was created based on the statements that students generally evaluate the distance education process. The “Education platform” code (*f*=7, 19.44%) includes the opinions about the education platforms used by the universities in the distance education process. In the other codes created, there are expressions related to synchronous education, crisis process and management, in-service training, administrators' control and intervention authority over the teaching staff, and education systems in general.

Discussion

The education process consists of students, lecturers, courses, methods, and learning environments (Bacanlı, 2021). On the other hand, the learning environment is considered the physical characteristics of the environment where learning occurs and all kinds of environmental factors that affect learning (Sahranç, 2019b). The student is at the centre of the education process (Sahranç, 2019a), and there are factors that positively or negatively affect the student's education, making it easier or harder to learn. These are factors related to the student, the teaching method, the learning material, the learning environment, and the educator (Yeşilyaprak, 2020). All of these factors will be decisive in achieving the goals of the education applied.

With distance education, a flexible, rich, and interactive education environment can be created apart from the stereotyped structure of traditional education. At the same time, many factors such as buildings, classrooms, and educational materials that limit the capacity of students to participate in education are prevented, thereby reducing the cost of education. From this point of view, the importance of distance education cannot be ignored (Özbay, 2015).

In the study, according to participant opinions, the positive aspects of distance education were determined as the absence of time and space limits, technological opportunities and course repetition, variety of teaching and resources, ease of access to information, economy, and reducing the spread of pandemics.

In line with the research conducted by Özdoğan and Berkant (2020) on school administrators, teachers, and students, the advantages of distance education can be made more often than face-to-face education regardless of time and place, the lessons can be watched many times, the training needs can be met within certain restrictions, it provides protection against the transmission of the disease, and the awareness of the importance of technology in education increases. They listed them as developing technological skills and facilitating learning.

In the study conducted by Dolmacı and Dolmacı (2020), in which lecturers' views on distance education were determined, it was stated that distance education has opportunities such as providing time-space flexibility, facilitating access to resources, preventing classroom pressure, and preventing discipline problems. In the study conducted by Cejas Martinez et al. (2021), it was stated as the positive aspect of distance education that there is no time and place limit in the learning-teaching process.

Serçemeli and Kurnaz (2020) on undergraduate students, the opportunity to rewatch video recordings, the flexibility of education options, and the time savings are all cited as advantages of distance education.

In Alpaslan's (2020) study on the views of faculty members on the use of distance education, the opinions in the category of advantages of distance education are; distance education is practical, flexible, independent of time and place, creating an alternative education environment, enriching the educational environment, easily adapting to new situations, providing equality in access to information, directing the use of computers to a good field and enabling students to take lessons from different teachers.

Markovič Krstić and Miloševič Radulović (2021) evaluated the distance education process in Serbia in their study. According to the results of the study, they stated that distance education provides flexibility as students and teachers can determine the place, time and pace of learning themselves, increases the effectiveness of education, encourages students' creativity, and more effective learning occurs in a short time.

In the study conducted by Uluöz (2020) on sports science students, ease of access for students with disabilities, protection of health, opportunities provided by the university administration, the chance to watch the course again, exam advantage, and encouraging research are positive opinions about distance education.

When the relevant literature is examined, it is seen that similar results regarding the positive aspects of distance education have been reached in the studies.

Considering the contagious effect of the Covid 19 pandemic, the transition to quarantine measures and distance education has also caused negativities in the Turkish education system, leading to the formation of education inadequacy. Lack of education can be social, political, economic, etc. It can be defined as the inability of education to be carried out, planned, and presented correctly for various reasons (Köroğlu, 2021). Distance education practices are also one of the practical reasons for the emergence of negativities that cause education inadequacy.

In the study, the participants' most emphasized negativities towards distance education were identified as communication problems, problems in accessing and participating in classes, motivation problems, ineffective teaching of applied lessons, and inequality of opportunity. These problems prevent the effective execution of the lessons and make it difficult to realize the essential functions of education. When the relevant literature is examined, it has been determined that the studies conducted have obtained results in parallel with the study's findings.

In the study conducted by Yolcu (2020) on prospective classroom teachers, it was concluded that the technical equipment of the students is insufficient, they do not have the opportunity to ask questions during distance education, their communication with educators and their friends is incomplete, and distance education is not suitable for practical lessons. According to Şişman (2020), the individual learns in various ways (listening, reading, seeing, speaking, doing some work). In these learning activities, there is an order from the most passive to the most active. As the activity increases, the learning power and effectiveness also increase. Active participation, where several of these are used, is significant as it affects attention, perception, and motivational factors. The individual's attention, perception, and motivation who learns something by doing can be carried to the highest possible level. Educational efficiency decreases as distance education in departments where applied courses are intense and learning cannot be realized. In the study conducted by Gorghiu et al. (2021), it was concluded that students have a lower perception of the usefulness of distance education due to the inability to carry out applied courses and laboratory studies.

In the study conducted by Doğan and Zorkol (2021) on teachers affiliated with the Ministry of National Education (MEB), the lack of eye contact and emotion transfer in distance education and difficulties in feedback and communication with students was expressed as disadvantages. According to the answers obtained from the students' opinions in Türküresin's (2020) study, the most damaging element regarding the distance education system is the lack of interaction.

In the studies of Serçemeli and Kurnaz (2020), issues such as not accessing the Internet and the lecturer and feeling socially isolated were identified as the negative aspects of distance education.

In the study of Özdoğan and Berkant (2020), the disadvantages of distance education are listed as follows; Inadequate measurement and evaluation, loss of motivation, lack of Internet and computers, inequality of opportunity, lack of interaction, technical problems, lack of socialization and being caught unprepared for the process.

Avcı and Akdeniz (2021), in their study on the problems faced by MEB teachers regarding the distance education process, emphasized that teachers often have issues with technological infrastructure and the Internet, and students' connection problems and their inability to attend live classes cause inequality of opportunity in education. Lautenbach and Randell (2020) stated that one of the most critical problems is that students who do not have internet access cannot participate in distance education.

In the study, the difficulties experienced by the lecturers in the distance education process were also tried to be determined. Accordingly, the participants stated that they had difficulties in communicating with students regarding lessons and infrastructure problems. The students' indifference to the lessons in the distance education process, the difficulty in communicating with them, and the ineffective implementation of the assessment and evaluation system prevent the lessons from being taught efficiently. In addition, the fact that the necessary equipment and internet infrastructure for the conduct of the courses are not provided equally to everyone has been identified as another reason that reduces the educational efficiency.

In the study of Dolmacı and Dolmacı (2020), it was determined that face-to-face education was found to be more efficient due to its advantages such as being able to deal with students one-on-one, making eye contact, communicating with body language, providing active participation and motivation in the lesson, and ease in assessment and evaluation.

Keskin and Kaya (2020) found that most of the students (84.4%) did not find web-based distance education as effective as face-to-face education and more than half (53.9%) of them had technical problems during their education.

Karakuş et al. (2020) concluded that the most common technical problems experienced by Turkish pre-service teacher candidates in the distance education process are the internet/connection problems and device/hardware deficiency. According to Manuel et al. (2021), students' most significant challenge is poor internet connection in rural areas. Weak internet signal prevents students from actively participating in distance education.

According to the research conducted by Karadağ and Yücel (2020) on 17,939 undergraduate students, 51% of the students stated that they were dissatisfied with the lecturers' teaching skills.

According to the results of the research conducted by Karadağ et al. (2021), in which the distance education capacities of universities were examined during the Covid-19 pandemic, distance education offered at universities in Turkey; It has been determined that universities are low and insufficient in terms of human resources, hardware and software infrastructures and capacities, content production capacities, examination infrastructures, and capacities and budgets.

According to the study of Dhurumraj et al. (2020), challenges in remote education include exorbitant data costs, the time it takes to develop presentations, the absence of professional help needed to navigate virtual digital platforms, and technical difficulties with the use of information and communication technology equipment.

In the study, views on the management of the distance education process are also included. According to the participants, although distance education is a practical system that can be applied in mandatory situations, it is stated that the process is not managed correctly. According to the participant's views, the decision-making authorities during the transition to and implementation of the distance education process in Turkey avoided taking responsibility and left the decisions to the universities. On the other hand, universities left the decisions about the process to the departments and departments to the lecturers. As a result, the decisions to be taken were delayed, and the process was disrupted. Apart from this, the administrators' involvement in the teaching of the courses by following the lecturers closely during the distance education process, the problems experienced during the use of synchronous education platforms, and the insufficient training of the lecturers for these platforms revealed the views that the crisis process was not managed effectively enough.

Managers have essential duties in minimizing the adverse effects of distance education. In particular, administrators will have a significant impact on ensuring the motivation of lecturers, students, and parents and ensuring the continuation of educational activities with minimal disruption in this process (Akyavuz & Çakın, 2020). One of the issues that managers should pay attention to in using distance education platforms is data security because these platforms process both public and private personal data of students and educators. All of these personal data must be handled in line with Law No. 6698 on Personal Data Protection. It is essential to follow the law when recording courses and exams offered through platforms and transferring data to third parties. Otherwise, if required by law, criminal and administrative responsibilities arise (Özçelik, 2021). Higher education today has a variety of learning objectives that require a well-rounded set of educational strategies. Since students' learning needs also vary, offering options to all students has become an important issue (Eastman & Swift, 2001). Therefore, dividing education into two classes, formal and distance, is a result of thinking with the norms of the past century. There is no room for such artificial divisions in the future. There is a place for both face-to-face and (with different versions) online training in optimally designed training. How to blend these different modes of transmission is complete; it should be left to universities, faculties, departments, and, in the final analysis, to the teaching staff (Erkut, 2020). However, it is necessary to monitor and evaluate educational practices by education administrators and policymakers and correct any deficiencies. Otherwise, the education system implemented with these deficiencies will cause learning losses (Koç, 2021).

Although it is difficult to predict the future, we should not forget that learning is a social and emotional process rather than the assimilation of information. Learning also requires reflecting, evaluating, interpreting, and combining it. Confronting conflicting information, building a cohesive argument, and openly sharing ideas with others are also part of learning. The Internet can help learners in the first step by making information accessible. On the other hand, universities help in other aspects of learning by providing good tutorial models, both online and in-person, by supporting course processes and live learning communities (Kaya, 2019). Online education will continue to develop and become widespread in the coming years. For institutions that want to be at the forefront of education, it would be wise to embrace the opportunities presented by this new teaching and learning paradigm (Eastman & Swift, 2001)

Conclusions and Implications

Distance education is an alternative model that can be used in cases where the formal education system is disrupted for any reason. Although the developments in information technologies have reached advanced dimensions, the problems experienced in distance education systems negatively affect the course functioning of the educators and the level of participation of the students in the course. Therefore, it can be said that research studies on distance education are important in order to create a functional education model.

Although the study aimed to evaluate the distance education process in sports sciences, it is seen that the research findings made in different fields are similar. However, the inclusion of applied courses in sports education and the limited conduct of these courses through distance education can be considered another aspect from the areas based on theoretical education. As a result of the distance execution of applied sports lessons, students may experience learning losses and inadequacies. Therefore, distance education in sports sciences should be handled with its different dimensions specific to the field. It should be designed and implemented according to the courses' targeted outputs, to applied lessons, and students' accessibility to distance education.

Another critical issue that arises in distance education is data security. The recording of lecturers and students during the lessons, how these records are stored, and who can access the records are issues that need attention in terms of protecting personal data. For the distance education process to be carried out in accordance with individual rights, technical, administrative, and legal measures regarding data security should be carefully carried out by subject experts.

Distance education applied during the Covid 19 process has positives and negatives for lecturers and students. This situation also varies according to the departments. Studies to be carried out for lecturers and students in different departments will contribute to negativities. Therefore, more research is required to determine distance education's efficacy, advantages, and disadvantages.

References

Akyavuz, E. K., & Çakın, M. (2020). Covid-19 salgınının eğitime etkisi konusunda okul yöneticilerinin görüşleri [School administrators' views on the effect of Covid-19 pandemic on education]. *Turkish Studies, 15*(4), 723-737. https://dx.doi.org/10.7827/TurkishStudies.44140

Alpaslan, M. (2020). Öğretim üyelerinin özel yeteneklilerin eğitiminde uzaktan eğitimin kullanımına yönelik görüşleri [Opinions of faculty members on the use of distance education in the education of gifted students]. *Açıköğretim Uygulamaları ve Araştırmaları Dergisi, 6*(1), 126-147. https://dergipark.org.tr/tr/pub/auad/issue/55639/761315

Altany, A. (2009). Distance learning and the scholarship of teaching and learning. In P. Rogers, G. Berg, J. Boettecher, C. Howard, L. Justice, & K. Schenk (Eds.), *Encyclopedia of distance learning* (2nd ed., Vol. 2, pp. 731–735). Information Science Reference.

Avcı, F., & Akdeniz, E. C. (2021). Koronavirüs (Covid-19) salgını ve uzaktan eğitim sürecinde karşılaşılan sorunlar konusunda öğretmenlerin değerlendirmeleri [Assessment of teachers on the Covid-19 epidemic and problems encountered in distance learning process]. *Uluslararası Sosyal Bilimler ve Eğitim Dergisi, 3*(4), 117-154. https://dergipark.org.tr/tr/pub/usbed/issue/61198/910183

Bacanlı, H. (2021). *Eğitim psikolojisi* [Education psychology] (27th ed.). Pegem Akademi.

Can, E. (2020). Coronavirüs (Covid-19) pandemisi ve pedagojik yansımaları: Türkiye'de açık ve uzaktan eğitim uygulamaları [Coronavirus (Covid-19) pandemic and its pedagogical reflections: Open and distance education practices in Turkey]. *Açıköğretim Uygulamaları ve Araştırmaları Dergisi, 6*(2), 11-53. https://dergipark.org.tr/tr/pub/auad/issue/55662/761354

Cejas Martinez, M. F., Navarro Cejas, M., Venegas Alvarez, G. S., Proano Rodriguez, C. E., & Mendoza Velazco, D. J. (2021). Student perceptions of Ecuadorian virtual platforms during the Covid-19 pandemic. *Problems of Education in the 21st Century, 79*(2), 241-254. https://doi.org/10.33225/pec/21.79.241

Dhurumraj, T., Ramaila, S., Raban, F., & Ashruf, A. (2020). Broadening educational pathways to STEM education through online teaching and learning during Covid-19: Teachers' perspectives. *Journal of Baltic Science Education, 19*(6A), 1055–1067. https://doi.org/10.33225/jbse/20.19.1055

Doğan, S., & Zorkol, F. (2021). Uzaktan eğitim ve yüz yüze eğitim süreçlerinde sınıf disiplini: Karşılaştırmalı bir olgubilim araştırması [Classroom discipline in distance education and face-to-face education processes: A comparative phenomenology study]. In Ş. Koca & M.Ş. Akgül (Eds.), *Eğitim bilimlerinde araştirma ve değerlendirme I* (pp. 15-35). Gece Kitaplığı.

Dolmacı, M., & Dolmacı, A. (2020). Eş zamanlı uzaktan eğitimle yabancı dil öğretiminde öğretim elemanlarının görüşleri: Bir Covid 19 örneği [The views of lecturers in foreign language teaching via synchronous distance education: A Covid 19 case]. *Türk Eğitim Bilimleri Dergisi, 18*(2), 706-732. https://doi.org/10.37217/tebd.783986

Eastman, J. K., & Swift, C. O. (2001). New horizons in distance education: The online learner-centered marketing class. *Journal of Marketing Education, 23*(1), 25–34. https://doi.org/10.1177/0273475301231004

Erkut, E. (2020). Covid-19 sonrası yükseköğretim [Higher education after Covid-19]. *Yükseköğretim Dergisi, 10*(2), 125–133. https://doi.org/10.2399/yod.20.002

Ferruci, F., Scanniello, G., & Tortora, G. (2009). E-world: A platform for the management of adaptive e-learning processes. In M. R. Syed (Ed.), *Methods and applications for advancing distance education technologies: International issues and solutions* (pp. 9-25). Information Science Reference.

Gorghiu, G., Pribeanu, C., Manea, V. I., Lamanauskas, V., & Makarskaitė-Petkevičienė, R. (2021). The usefulness of online learning during the Covid19 pandemic as perceived by engineering education students: A multidimensional model. *Journal of Baltic Science Education, 20*(5), 716-728. https://doi.org/10.33225/jbse/21.20.716

Hiep-Hung P., & Tien-Thi-Hanh H. (2020) Toward a 'new normal' with e-learning in Vietnamese higher education during the post COVID-19 pandemic. *Higher Education Research & Development, 39*(7), 1327-1331. https://doi.org/10.1080/07294360.2020.1823945

Holmberg, B. (2008). *The evolution, principles and practices of distance education*. Bibliotheks- und Informations system der Universitat Oldenburg. https://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.466.9000&rep=rep1&type=pdf

Karadağ, E., Çiftçi, S. K., Gök, R., Su, A., Kocatürk, H. E., & Çiftçi, Ş. S. (2021). Covid-19 pandemisi sürecince üniversitelerin uzaktan eğitim kapasiteleri [Distance education capacities of universities during the Covid-19 pandemic process]. Üniversite *Araştırmaları Dergisi, 4*(1), 8-22. https://dergipark.org.tr/tr/pub/uad/issue/60894/874799

Karadağ, E., & Yücel, C. (2020). Yeni tip koronavirüs pandemisi döneminde üniversitelerde uzaktan eğitim: Lisans öğrencileri kapsamında bir değerlendirme çalışması [Distance education at universities during the novel coronavirus pandemic: An analysis of undergraduate students' perceptions]. *Yükseköğretim Dergisi, 10*(2), 181-192. https://doi.org/10.2399/yod.20.730688

Karakuş, N., Ucuzsatar, N., Karacaoğlu, M., Esendemir, N., & Bayraktar, D. (2020). Türkçe öğretmeni adaylarının uzaktan eğitime yönelik görüşleri [Turkish teacher candidates' views on distance education]. *RumeliDE Dil ve Edebiyat Araştırmaları Dergisi, 19*, 220-241. https://doi.org/10.29000/rumelide.752297

Kaya, A. B. (2019). Küreselleşme çağında yükseköğretimin yeniden yapılandırılması [Restructuring higher education in the age of globalization]. In C. Celep (Ed.), *Karşılaştırmalı eğitim yönetimi* (pp. 133-163). Hiperyayın.

Keskin, M., & Kaya, D. Ö. (2020). Covid-19 sürecinde öğrencilerin web tabanlı uzaktan eğitime yönelik geri bildirimlerinin değerlendirilmesi [Evaluation of students' feedbacks on web-based distance education in the Covid-19 process]. İzmir *Katip* Çelebi Üniversitesi *Sağlık Bilimleri Fakültesi Dergisi, 5*(2), 59-67. https://dergipark.org.tr/tr/pub/ikcusbfd/issue/55773/754174

Kırık, A. M. (2014). Uzaktan eğitimin tarihsel gelişimi ve Türkiye'deki durumu [Historical development of distance education and the situation in Turkey]. *Marmara* İletişim *Dergisi, 21*, 73-94.

Koç, E. S. (2021). Nasıl bir uzaktan eğitim? 1 yılın sonunda yapılan çalışmaların değerlendirilmesi [What kind of distance education? An evaluation of the studies done at the end of 1 year]. *International Anatolia Academic Online Journal Social Sciences Journal, 7*(2), 13-26. https://dergipark.org.tr/tr/pub/iaaoj/issue/60800/892227

Köroğlu, İ. S. (2021). Covid-19 sürecinde eğitim yoksulluğu [Educational poverty during the Covid-19]. *Internatıonal Journal of Economıc and Admınıstratıve Academıc Research, 1*(2), 74–89. https://www.ijerdergisi.com/index.php/ijer/article/view/16/20

Lautenbach, G., & Randell, N. (2020). Through the Covid-19 looking glass: Coping skills for STEM educators in the time of a pandemic and beyond. *Journal of Baltic Science Education, 19*(6A), 1068-1077. https://doi.org/10.33225/jbse/20.19.1068

Manuel, A., Buque, D., & Quive, R. (2021). Students' perceptions on distance education: A case study in Mozambique. *Problems of Education in the 21st Century, 79*(2), 229-240. https://doi.org/10.33225/pec/21.79.229

Markovič Krstić, S. V., & Miloševič Radulović, L. R. (2021). Evaluating distance education in Serbia during the Covid-19 pandemic. *Problems of Education in the 21st Century, 79*(3), 467-484. https://doi.org/10.33225/pec/21.79.467

Mellieon, H. I. Jr., & Robinson, P. A. (2021). The new norm: Faculty perceptions of condensed online learning. *American Journal of Distance Education, 35*(3), 170-183. https://doi.org/10.1080/08923647.2020.1847626

Miles, M. B., & Huberman, A. M. (1994). *Qualitative data analysis: An expanded sourcebook* (2nd ed.). SAGE Publications.

Moore, M. G. (1973). Toward a theory of independent learning and teaching. *The Journal of Higher Education, 44*(9), 661-679. https://doi.org/10.2307/1980599

Naidu, S. (2021). Building resilience in education systems post-COVID-19. *Distance Education, 42*(1), 1-4. https://doi.org/10.1080/01587919.2021.1885092

Özbay, Ö. (2015). Dünya'da ve Türkiye'de uzaktan eğitimin güncel durumu [The current status of distance education in the world and Turkey]. *Uluslararası Eğitim Bilimleri Dergisi, 2*(5), 376-394. https://dergipark.org.tr/tr/pub/inesj/issue/40015/475774

Özçelik, F. K. (2021). Covid-19 salgını sürecinde üniversite eğitiminde kullanılan uzaktan eğitim platformlarının 6698 sayılı kişisel verilerin korunması kanunu çerçevesinde değerlendirilmesi [The evaluation of distance education platforms used in university education during Covid-19 pandemic disease under the personal data protection law]. *Süleyman Demirel* Üniversitesi *Hukuk Fakültesi Dergisi, 11*(1), 135-170. https://doi.org/10.52273/sduhfd..928688

Özdoğan, A., & Berkant, H. (2020). Covid-19 pandemi dönemindeki uzaktan eğitime ilişkin paydaş görüşlerinin incelenmesi [The examination of stakeholders' opinions on distance education during the Covid-19 epidemic]. *Milli Eğitim Dergisi, Salgın Sürecinde Türkiye'de ve Dünyada Eğitim, 49*(1), 13-43. https://doi.org/10.37669/milliegitim.788118

Raymond, F. B. (2005). The history of distance education in social work and the evolution of distance education modalities. In P. Abels (Ed.), *Distance education in social work planning, teaching, and learning* (pp. 23-40). Springer Publishing Company.

Sahranç, Ü. (2019a). Öğrenmeyi etkileyen etkenler [Factors affecting learning]. In İ. Yıldırım (Ed.), *Eğitim psikolojisi* (8th ed., pp. 363-386). Anı Yayıncılık.

Sahranç, Ü. (2019b). Temel öğrenme ortamları: Aile-okul-sınıf [Basic learning environments: Family-school-classroom]. In İ. Yıldırım (Ed.), *Eğitim psikolojisi* (8th ed., pp. 333-362). Anı Yayıncılık.

Serçemeli, M., & Kurnaz, E. (2020). Covid-19 pandemi döneminde öğrencilerin uzaktan eğitim ve uzaktan muhasebe eğitimine yönelik bakış açıları üzerine bir araştırma [A research on students' perspectives to distance education and distance accounting education in the Covid-19 pandemia period]. *Uluslararası Sosyal Bilimler Akademik Araştırmalar Dergisi, 4*(1), 40-53. https://dergipark.org.tr/tr/pub/utsobilder/issue/55152/741358

Shih, T. K., Hung, J. C., Ma, J., & Jin, Q. (2007). A survey of distance education challenges and technologies. In T. K. Shih & J. C. Hung (Eds.), *Future directions in distance learning and communication technologies* (pp. 1-25). IGI Global.

Simonson, M., Smaldino, S., & Zvacek, S. (2015). *Teaching and learning at a distance foundations of distance education* (6th ed.). Information Age Publishing.

Şişman, M. (2020). *Eğitime giriş* [Introduction to education] (21st ed.). Pegem Akademi.

Türküresin, H. E. (2020). Covid-19 pandemi döneminde yürütülen uzaktan eğitim uygulamalarının öğretmen adaylarının görüşleri bağlamında incelenmesi [Examination of distance education practices conducted during the Covid-19 pandemic regarding the views of preservice teachers]. *Milli Eğitim Dergisi, Salgın Sürecinde Türkiye'de ve Dünyada Eğitim, 49*(1) 597-618. https://doi.org/10.37669/milliegitim.787509

Uluöz, E. (2020). Opinions of the faculty of sport sciences students on the changes in education system during Covid-19 pandemic: A qualitative research. *African Educational Research Journal, 8*(3), 481-490. https://doi.org/10.30918/AERJ.83.20.114

Wedemeyer, C. A. (1981). *Learning at the back door: Reflections on non-traditional learning in the lifespan*. The University of Wisconsin Press.

Yamamoto, G. T., & Altun, D. (2020). Coronavirüs ve çevrimiçi (online) eğitimin önlenemeyen yükselişi [The coronavirus and the rising of online education]. Üniversite *Araştırmaları Dergisi, 3*(1), 25-34. https://doi.org/10.32329/uad.711110

Yeşilyaprak, B. (2020). *Eğitim psikolojisi gelişim-öğrenme-öğretim* [Educational psychology development-learning-teaching] (23rd ed.). Pegem Akademi.

Yıldırım, A., & Şimşek, H. (2016). *Sosyal bilimlerde nitel araştırma yöntemleri* [Qualitative research methods in the social sciences] (10th ed.). Seçkin yayıncılık.

Yılmaz, A. B., & Karataş, S. (2020). Açık ve uzaktan öğrenmenin temel kavramları, kuramları ve felsefesi [Basic concepts, theories and philosophy of open and distance learning]. In E. Tekinarslan & M.D. Gürer (Eds.), *Açık ve uzaktan* öğrenme (3rd ed., pp. 1-28). Pegem Akademi.

Yolcu, H. (2020). Koronavirüs (Covid-19) pandemi sürecinde sınıf öğretmeni adaylarının uzaktan eğitim deneyimleri [Preservice elementary teachers' distance education experiences at the time of Coronavirus (Covid-19) pandemic]. *Açıköğretim Uygulamaları ve Araştırmaları Dergisi, 6*(4), 237-250. https://dergipark.org.tr/tr/pub/auad/issue/57638/788890

Yurdakul, I. K. (2013). Evren ve örneklem [Universe and sample]. In A.A. Kurt (Ed.), *Bilimsel araştırma yöntemleri* (pp. 75-92). Anadolu Üniversitesi Açıköğretim Fakültesi Yayınları.

Received: *November 19, 2021* Accepted: *January 20, 2022*

Cite as: Özer, U. (2022). Evaluation of distance education process in sports higher education. *Problems of Education in the 21st Century*, *80*(1), 195-212. https://doi.org/10.33225/pec/22.80.195

Uğur Özer

PhD, Assistant Professor, Department of Sport Management, Hitit University Vocational School of Social Sciences, Çorum-Turkey.
E-mail: ugurozer84@hotmail.com
Website: http://web.hitit.edu.tr/ugurozer
ORCID: https://orcid.org/0000-0002-3899-3429

This is an open access article under the
Creative Commons Attribution 4.0
International License

REFLECTIVE THINKING AND INQUIRY SKILLS AS PREDICTORS OF SELF-EFFICACY IN TEACHING MATHEMATICS

Mehtap Saracoglu
Siirt University, Turkey
E-mail: mehtapsarac@siirt.edu.tr

Abstract

This study aims to show to what extent the variables of reflective thinking, inquiry skill and mathematics teaching self-efficacy belief affect each other, to show their rates of explaining each other, and to show whether inquiry skill is a mediating variable in the relationship between reflective thinking and mathematics teaching self-efficacy belief. The data which were collected to test the hypotheses regarding the relationships to be shown were evaluated with structural equation modeling. A relational screening model was used in the research. The participants of the study were 304 prospective primary school teachers studying in their third and fourth years in the Basic Education Department of Education Faculties in two different state universities in Turkey. As data collection tools, the "Reflective Thinking Level Determination Scale", "Inquiry Skills Scale" and "Mathematics Teaching Efficacy Belief Instrument" were used. According to the results of the study, reflective thinking affects mathematics teaching self-efficacy belief positively and significantly and explains it significantly. Reflective thinking affects inquiry skills positively and significantly and explains it significantly. Inquiry skill affects mathematics teaching self-efficacy belief positively and significantly. Reflective thinking and inquiry skill together explain mathematics teaching self-efficacy belief highly and significantly. Inquiry skill has a partial mediating effect between reflective thinking and mathematics teaching self-efficacy belief.

Keywords: *Inquiry skill, mathematics teaching, prospective primary school teachers, reflective thinking, teacher education*

Introduction

Knowledge production, which has had a serious impact on the 21st century, has caused changes and developments in many lines of work. While developing education policies, this change and development, the needs of the new generation and the business sector should be taken into account, and children should be educated in a way that will be appropriate for the age they will struggle in the future. For this reason, we need to raise individuals who question, research, have advanced problem-solving skills, high-level thinking skills, and high reflective thinking skills.

Mathematics education, which starts in the preschool period, has a significant place in individuals' lives and affects their attitudes towards mathematics positively and negatively. Therefore, primary school teachers have a great role in students' learning mathematics and developing self-efficacy perceptions (Arseven et al., 2015). Determining the mathematics self-efficacy beliefs of prospective primary school teachers is important in understanding their behaviors more correctly and increasing the academic achievement of students in the future.

Students' attitudes towards mathematics are shaped by the education they receive at school. Self-efficacy belief, which is considered a very important guide of the individual's behaviors and adaptation to the environment, is one of the important factors of the effective field of mathematics teaching. Self-efficacy belief, which is known to have a strong effect on the

ISSN 1822-7864 (Print) ISSN 2538-7111 (Online) https://doi.org/10.33225/pec/22.80.213

achievement levels of individuals, is also an effective antecedent of their success in mathematics. Teachers' belief in self-efficacy affects the quality of teaching and has an important role in students' success (Çağırgan-Gülten et al., 2012). Toluk-Uçar et al. (2010) stated that students' beliefs about mathematics are subjective thoughts which arise from students' past mathematics experiences accepted as true by students. Therefore, students' beliefs about the mathematics they form in the first years of their formal education affect their whole education life. For this reason, mathematics teaching self-efficacy beliefs of primary school teachers, who will introduce students to mathematics and who will make them love mathematics, is very important. This is because one of the factors that affect students' success and attitude is the beliefs their teachers have and the learning environments they form according to their beliefs (Birgin, 2016). There is a close relationship between teachers' ability to teach mathematics effectively and their beliefs, perceptions, and self-efficacy towards mathematics teaching skills (Swars et al., 2007). Teachers who think that their self-efficacy perceptions about their teaching skills are important for students to be successful in providing effective teaching in the mathematics teaching process are more successful than teachers who think that their self-efficacy perceptions will not affect their success (Enochs et al., 2000). In other words, high self-efficacy perceptions of primary school teachers have a direct effect on students' academic achievement.

In its most general sense, reflective thinking is the individual's thinking deeply about the past/future and present experiences, questioning his/her learning/teaching and thinking process, and evaluating the self and thinking about what he/she can do to solve the problems as a result of this evaluation. While gaining learning experiences, students will try to make their learning processes productive by subjecting these experiences, their educational beliefs, and the knowledge they gain to constant questioning. Teachers will on the one hand make students question by guiding the use of this skill, while on the other hand, they will reflect on their teaching by examining their guidance process (Wilson & Jan, 1993). According to Taggart and Wilson (2005), reflective thinking is the process of making informed and logical decisions on teaching issues and evaluating the consequences of these decisions. Norton (1997) defined creative thinking as an inquiry about the reasons, methods, materials, and consequences of educational practice. Reflective thinking, which is a high-level cognitive skill, has come to the fore as the main subject in constructivist understanding. This is because, through reflective thinking, which is an inquiry approach that cares about constructivism in teaching, individuals find the opportunity to reconstruct their experiences (Mahnaz, 1997). It is thought that reflective teachers' ability to reflect their actions in mathematics teaching practices will contribute positively to their problem-solving skills. In this sense, the necessity of reflective thinking skills in mathematics teaching emerges (Gözel & Toptaş, 2017).

In mathematics teaching, primary school teachers should guide their students to reflective thinking during the process of problem-solving, they should ensure that their students question and evaluate what they do and establish cause-effect relationships between events and concepts (Baş & Kıvılcım, 2013). According to Gipe and Richards (1992), reflective thinking is a questioning process, and it results in self-development. Schön (1987) emphasized that in courses given in educational institutions, students were generally prepared for problems that have only one solution and which are always well-defined, whereas they had to be educated as individuals with more advanced reflecting skills so that they could cope with complex and incompletely defined problems. According to Dewey (1933), reflective thinking is the ability of individuals to think effectively, consistently, and carefully about any thought or knowledge and a knowledge structure that supports reaching its intended results. Dewey (1933) stated that individuals with reflective thinking skills should be open-minded, willing, and responsible individuals. When a skill has to be measured, it is necessary to examine the actions which reveal that skill (Kızılkaya & Aşkar, 2009). In this context, it has been stated that one of the acts that show reflective thinking skills is inquiry (Dewey, 1933). According to Branch and Solowan

(2003), since inquiry is a student-centered learning approach focused on asking questions, thinking critically, and solving problems, it enables students to develop skills they may need all their lives and help them to cope with problems.

The foundations of the concept of inquiry go back to Socrates. The inquiry has been discussed by many researchers, including Dewey (1926, 1933, 1938), Conant in the 1940s, Bruner, Suchman, Schwab, and Gagne in the 1960s, and Piaget and Lawson in the 1980s. Inquiry means seeking explanations or information by asking questions. In inquiry learning, students choose a subject that interests them, they study this subject in-depth, and they share what they learn. Students ask questions, analyze information, and they are active during the learning process; therefore, the inquiry is based on a constructivist learning approach. Inquiry skill engages students in the learning process; students take responsibility for their learning and thus maximize learning. Inquiry-based learning enables students to develop their skills of critical thinking, scientific processing, and problem-solving (Bell et al., 2005; Chung & Behan, 2010). Llewellyn (2002) stated that the inquiry-based learning approach provides students with the necessary skills to become free individuals and lifelong learners. Inquiry skill helps students to develop lifelong learning skills. Lawson (2010) advocated that the inquiry-based learning approach develops students' creativity, academic achievement, critical thinking skills, and problem-solving skills.

There are studies in the literature that examined the effects of inquiry-based learning methods on students' academic achievement. Varlı and Uluçınar-Sağır (2019) concluded that inquiry-based learning approach has a significant effect on students' academic achievement, inquiry learning skills, and metacognition. Abdi (2014) examined the effects of the inquiry-based learning method on students' academic achievement in a science lesson. It was found that the students who received education through inquiry-based learning got higher scores when compared with the students who were educated with the traditional method. Akpullukçu (2011) found that using practices in a research-based learning environment in science and technology lessons could be beneficial for students' academic achievement and developing students' attitudes towards the lesson. In literature, inquiry-based teaching has been applied in many courses and the efficacy of this teaching method has been examined in terms of different variables considered. It was found that inquiry-based teaching increased academic achievement, enabled students to develop positive attitudes for courses, ensured the permanence of information, developed logical thinking skills and scientific data processing skills and scientific process skills (Bağcaz, 2009; Balım et al., 2008; Budak Bayır, 2008; Çeliksöz, 2012; Davies et al., 2012; Duban, 2008; Erdoğan, 2005; Evrekli, 2010; Evren, 2012; Gençtürk, 2004; Güngör Seyhan, 2008; Kara, 2008; Küçük, 2012; Sağlam, 2012; Sözen, 2010; Şen, 2010; Taşkoyan, 2008; Timur, 2005).

There are also studies in the literature which discuss the reflective thinking skills of primary school teachers and prospective primary school teachers in terms of various variables. For example, Çelik and Dikmenli (2021) and Alkan and Gözel (2013) concluded that prospective primary school teachers had high reflective thinking tendency levels. Akar and Şahin (2020) and Kaf-Hasırcı and Sadık (2011) found that primary school teachers had high reflective thinking tendencies. Aras, Şiringül, and Park (2019) found that prospective teachers had high reflective thinking levels. Karapınar (2016) stated that inquiry-based learning environments were effective in prospective teachers' accessing knowledge with scientific validity and increasing scientific process skills that include the production process of knowledge.

The rapid change in science and technology, the changing needs of the individual and the society, the innovations and developments in learning and teaching theory and approaches also had a direct effect on the roles expected from individuals. It can be seen that in the primary mathematics lesson teaching program of our country, there are goals such as making an inquiry, making inferences about logical induction and deduction, thinking critically, developing problem-solving strategies, making research, developing the power to produce and use knowledge (Ministry of National Education [MoNE], 2018). As the organizers of learning environments, teachers should possess the skills that students should have as specified in Turkish National Education Programs because it is teachers that will develop the reflective thinking and inquiry skills of students. Teachers cannot be expected to educate their students to have the skills they do not have. Therefore, primary school teachers who will build the future should have high-level skills defined as 21st-century skills (creative-reflective-critical-scientific thinking, inquiry skill, problem-solving, communication, conflict solution, skills of using information and communication technologies). To be able to educate students with high inquiry skills and reflective thinking skills, primary school teachers, who are the implementers of the primary school program, should also have these skills. In this context, it becomes important to what extent reflective thinking and inquiry skills predict prospective primary school teachers' mathematics teaching self-efficacy beliefs. It is expected for prospective teachers who will graduate from the primary school teaching program to have high inquiry skills, high reflective thinking skills, and high self-efficacy perceptions towards mathematics. No known studies in literature explain the effects and impact of reflective thinking and inquiry-based learning on the development of mathematics self-efficacy for prospective primary school teachers. In this respect, the present study is of great importance.

Research Aim and Research Questions

In line with the literature on the relationship between reflective thinking, inquiry skills, and mathematics teaching self-efficacy, which are tried to be explained above, and the relationship between these three parameters the following hypotheses have been developed.

Hypotheses:

H1. Reflective thinking affects mathematics teaching self-efficacy belief positively and significantly.

H2. Reflective thinking explains the mathematics teaching self-efficacy belief meaningfully.

H3. Reflective thinking affects inquiry skills positively and significantly.

H4. Reflective thinking explains the inquiry skill meaningfully.

H5. Inquiry skill affects mathematics teaching self-efficacy belief positively and significantly.

H6. Reflective thinking and inquiry skills together explain mathematics teaching self-efficacy belief at a high level and meaningfully.

H7. Inquiry skill has a partial mediation effect between reflective thinking and mathematics teaching self-efficacy belief.

Research Methodology

Background

A relational screening model was used in the research. The relational screening model is a research model that aims to determine the existence and degree of change between two or more variables (Karasar, 2012). In this context, the study discussed the effects of prospective teachers' reflective thinking, inquiry skills, and mathematics teaching self-efficacy belief levels on each other and their levels of explaining each other.

Sample

The participants of the study were 304 prospective primary school teachers studying in their third and fourth years in the Basic Education Department of Education Faculties in two different state universities in Turkey in the 2019-2020 academic year. The study group was selected by the “criterion sampling” method, which is one of the purposive sampling methods. The basic understanding of the criterion sampling method is to study all cases that meet a predetermined set of criteria. The criteria or criteria mentioned here can be created by the researcher or a previously prepared criteria list can be used (Yıldırım & Şimşek, 2013). The basic criteria of this study are to be registered in the basic education department of education faculties of the universities and to be studying in the 3rd or 4th grade. Also, for the structural equation model, the data must meet the multiple normality assumption. It is stated that the minimum sample size should be between 100 and 150 to meet this assumption (Hair et al., 1998). In line with the criteria given above, the participant group of the research was determined as 304 people, and this number is suitable for the research and statistical analysis. In terms of gender, 62.2% (*f*=189) of the participants were “female” and 37.8% (*f*=115) are “male”. While 18.1% (*f*=55) of the participants were in the “20 and less” age group, 81.9% (*f*=249) were in the “21-30 age group”. In terms of grade level, 54.6% of the participants (*f*=166) were studying in the 3rd grade while 45.4% (*f*=138) were in the 4th grade.

Instrument and Procedures

Data Collection Tools

As data collection tools, “Reflective Thinking Level Determination Scale”, “Inquiry Skills Scale” and “Mathematics Teaching Efficacy Belief Instrument” were used. More detailed information on these scales, as well as confirmatory factor analysis results for the scales, are given below.

Reflective Thinking Level Determination Scale

This scale was developed by Kember et al. (2000) in order to measure the reflective thinking skill levels of students at the end of a lesson and was adapted into Turkish by Başol and Evin-Gencel (2013). It consists of 4 factors and 16 items: habit (4 items), understanding (4 items), reflecting (4 items) and critical reflecting (4 items). The Cronbach-alpha value calculated for the total of the scale whose validity and reliability studies were conducted by Başol and Evin-Gencel (2013) is .77. In the scale scoring is done as follows; 5=Strongly Agree, 4=Agree, 3=Neutral, 2=Disagree, 1=Strongly Disagree. Based on the data obtained from this study, Cronbach-alpha values for each factor in the scale and the entire scale were calculated. While Cronbach-alpha reliability coefficients were .70 for “Habit”; .74 for “Understanding”, .75 for “Reflecting” and .77 for “Critical reflecting”, it was .79 for the total of the scale.

Inquiry Skills Scale

The Inquiry Skills Scale, which aims to measure the inquiry skills of prospective school teachers, was developed by Aldan-Karademir and Saracaloğlu (2013). The scale consists of a total of 3 factors and 14 items, namely getting information (6 items), checking information (5 items), and self-confidence (3 items). The Cronbach-alpha value calculated for the sum of the scale by Aldan-Karademir and Saracaloğlu (2013) is .82. In scale scoring; Always=5, Often=4, Occasionally=3, Rarely=2, Never=1 points. Based on the data obtained from this study, Cronbach-alpha values for each factor in the scale and the entire scale were calculated. While the Cronbach-alpha reliability coefficients were .73 for “Getting Information”, .70 for “Checking Information” and .82 for “Self-Confidence”, they were .83 for the total scale.

Mathematics Teaching Efficacy Belief Instrument

The scale, which was developed by Enochs et al. (2000) and adapted into Turkish by Hacıömeroğlu and Şahin-Taşkın (2010), to determine the efficacy beliefs of primary school teachers regarding mathematics teaching consists of a total of 3 sub-dimensions and 17 items; personal competence (6 items), the role of the teacher in effective teaching (7 items) and teaching performance (4 items). The Cronbach-alpha value calculated for the total of the scale whose validity and reliability studies were conducted by Hacıömeroğlu and Şahin-Taşkın (2010) is .712. In the scale scoring, it is evaluated as 5=Strongly Agree, 4=Agree, 3=Undecided, 2=Disagree, 1=Strongly Disagree. Based on the data obtained from this study, Cronbach-alpha values for each factor in the scale and the entire scale were calculated. While the Cronbach-alpha reliability coefficients are .80 for “Personal competence”, .82 for “The role of the teacher ineffective teaching” and .72 for “Teaching performance”, they are .86 for the total scale.

Confirmatory factor analysis (CFA) was performed to test the validity of the scales used. The results obtained as a result of confirmatory factor analysis are shown in the table below (Table 1).

Table 1
The Results of Confirmatory Factor Analysis of Scales

***Fit Indices**	**$\Delta\chi^2$**	***df***	**$\Delta\chi^2/df$**	**RMSEA**	**SRMR**	**GFI**	**CFI**	**AGFI**	**NFI**
The Scale for Determining the Level of Reflective Thinking	316.22	112	2.823	.072	.056	.912	.946	.900	.926
The Inquiry Skills Scale	214.16	74	2.894	.074	.058	.924	.959	.903	.930
The Mathematics Teaching Efficacy Belief Instrument	319.44	124	2.576	.071	.076	.908	.912	.903	.908

As a result of the confirmatory factor analysis, in terms of multivariate (Mardia) values, the critical rate (c.r.) for “The Scale for Determining the Level of Reflective Thinking” was 42.246, the critical rate for “The Inquiry Skills Scale” (c.r.) was 44.325, and the critical rate (c.r.) for “The Mathematics Teaching Efficacy Belief Instrument” was 46.632. Since there were no items with a critical ratio greater than 10 for all three scales, all items were included in the analysis in the next step. In addition, when Table 1 is examined, it is seen that the fit values for the scales are at an acceptable level.

Data Analysis

The data obtained as a result of the application of the scales used in the research were entered into the SPSS (Statistical Package for the Social Sciences) package program and the demographic characteristics of the participant group were analyzed through this program. The AMOS (Analysis of Moment Structures) program was used for confirmatory factor analysis of the scales and the designed model. The maximum likelihood estimation method was used to estimate model parameters in confirmatory factor analysis. RMSEA (0-0,08), SRMR (0-0.10), GFI (.90-1.00), CFI (.90-1.00), AGFI (.85-1.00), NFI (90-1.00), χ^2/sd = CMIN/DF (0-3) and significance level (p) fit indices were taken into account in the evaluation of model goodness of fit (Bayram, 2010; Reisinger & Mavondo, 2007; Schermelleh-Engel et al., 2003; Şimşek, 2007). In this study, the lower limit of the factor loadings of the items in confirmatory factor analysis was accepted as .30. If there are few items in a scale prepared in the field of social sciences, the limit value for the factor load value can be reduced to .30 (Büyüköztürk, 2012). In addition, the assessment of normality for confirmatory factor analysis and structural equation modeling was based on a critical ratio below 10.

Research Results

Correlation Analysis

The mean and standard deviation values of the variables (dependent and independent variables) in the study and the correlation coefficients between the independent and dependent variables are given in Table 2.

Table 2
Descriptive Statistics and Correlation Matrix of Constructs

Constructs	$\bar{X}$	*SD*	1	2	3	4	5	6	7	8	9	10
1. Habit	3.20	0.77	(0.75)									
2. Understanding	3.95	0.61	.23**	(0.79)								
3. Reflecting	3.96	0.67	.19**	.57**	(0.73)							
4. Critical reflecting	3.40	0.77	.33**	.44**	.45**	(0.77)						
5. Getting information	4.12	0.58	.24**	.50**	.52**	.38**	(0.79)					
6. Checking information	3.81	0.65	.18**	.32**	.49**	.47**	.65**	(0.73)				
7. Self confidence	3.75	0.88	.23**	.24**	.23**	.24**	.30**	.26**	(0.74)			
8. Personal competence	4.00	0.79	.13**	.28**	.35**	.27**	.37**	.20**	.20**	(0.82)		
9. Teachers role in effective teaching	4.00	0.68	.13**	.44**	.46**	.34**	.57**	.41**	.19**	.32**	(0.83)	
10. Teaching performance	4.04	0.70	.18**	.44**	.51**	.38**	.54**	.53**	.16**	.27**	.74**	(0.80)

Note 1: **p*-value <.05, ***p*-value <.01, N = 304.

Note 2: Numbers in parentheses indicate the Cronbach's α of constructs.

According to the data in Table 2, it is seen that prospective primary school teacher' perception levels of reflection in terms of reflective thinking dimensions ($\bar{X}$ = 3.96) are higher than those of habit ($\bar{X}$ = 3.20), understanding ($\bar{X}$ = 3.95) and critical reflecting ($\bar{X}$ = 3.40). In terms of inquiry skill dimensions, the highest average score was in the dimension of getting information ($\bar{X}$ = 4.12), while the lowest average score was in the dimension of self-confidence ($\bar{X}$ = 3.75). In terms of mathematics teaching self-efficacy belief dimensions, it is seen that the highest average score is in the dimension of performance related to teaching ($\bar{X}$ = 4.04), while the lower and equivalent score averages are in the dimensions of personal competence ($\bar{X}$ = 4.00) and the role of the teacher in effective teaching ($\bar{X}$ = 4.00). The relationships between the variables of the study are explained below:

1) Relationships between reflective thinking and inquiry skills: It is seen that the habit dimension of the reflective thinking scale has a positive and significant relationship with the dimensions of the inquiry skill scale such as getting information (r = .24), checking information (*r* = .18) and self-confidence (*r* =.23). Also, the understanding dimension of the reflective thinking scale has a positive and significant relationship with the dimensions of the inquiry skill scale such as getting information (*r* = .50), checking information (*r* = .32), and self-confidence (*r* = .24); the reflection dimension of the reflective thinking scale has a positive and significant relationship with the dimensions of the inquiry skill scale such as getting information (*r* = .52), checking information (*r* = .49) and self-confidence (*r* = .23). Finally, it is seen that the critical reflecting dimension of the reflective thinking scale has a positive and significant relationship with the dimensions of the inquiry skill scale such as getting information (*r* = .38), checking information (*r* = .47), and self-confidence (*r* = .24). This shows that prospective primary school teachers with high reflective thinking skills will exhibit high inquiry skills.

2) Relationships between reflective thinking and mathematics teaching self-efficacy belief: It is seen that the habit dimension of the reflective thinking scale has a positive and significant relationship with the dimensions of the mathematics teaching self-efficacy belief scale such as personal competence (*r* = .13), the role of the teacher in effective teaching (*r* = .13), and teaching performance (*r* = .18); the understanding dimension of the reflective thinking scale has a positive and significant relationship with the dimensions of the mathematics teaching self-efficacy belief scale, such as personal competence (*r* = .28), the role of the teacher in effective teaching (*r* = .44), and teaching performance (*r* = .44); the reflection dimension of the reflective thinking scale has a positive and significant relationship with the dimensions of the mathematics teaching self-efficacy belief scale such as personal competence (*r* = .35), the role of the teacher in effective teaching (*r* = .46), and teaching performance (*r* = .51), Finally, the critical reflection dimension of the reflective thinking scale has a positive and significant relationship with the dimensions of the mathematics teaching self-efficacy belief scale, such as personal competence (*r* = .27), the role of the teacher in effective teaching (*r* = .34), and teaching performance (*r* = .38). This shows that prospective primary school teachers with high reflective thinking skills will have higher mathematics teaching self-efficacy beliefs.

3) Relationships between inquiry skill and mathematics teaching self-efficacy belief: The getting information dimension of the inquiry skill scale appears to have a positive and significant relationship with the dimensions of the mathematics teaching self-efficacy belief scale, such as personal competence (*r* = .37), the role of the teacher in effective teaching (*r* = .57), and teaching performance (*r* = .54), the inquiry skill scale's checking information dimension has a positive and significant relationship with the dimensions of the mathematics teaching self-efficacy belief scale, such as personal competence (*r* = .20), the role of the teacher in effective teaching (*r* = .41), and teaching performance (*r* = .53). Finally, the self-confidence dimension of the inquiry skill scale seems to have a positive and significant relationship with the dimensions of the mathematics teaching self-efficacy belief scale, such as personal competence (*r* = .20), the role of the teacher in effective teaching (*r* = .19), and teaching performance (*r* = .16). This shows that prospective primary school teachers with high inquiry skills will have higher mathematics teaching self-efficacy beliefs. Correlation analysis only reveals the level of correlation between structures. Structural equation model analyzes are required to understand the direct and indirect effects between the structures and even to reveal the mediating variables.

Structural Equation Models

In order to show the degree of influence of the variables of reflective thinking, inquiry skills and mathematics teaching self-efficacy beliefs under the title of structural equation models -and to understand the extent to which they explain each other, and to understand whether the inquiry skill is a mediating variable in the relationship between reflective thinking and mathematics teaching self-efficacy belief- two models were tested, namely "basic model" and "mediating model".

Base Model Results

Structural equation analysis was performed using covariance matrices according to maximum probability calculations. According to the results of the basic model shown in Figure 1, taking into account the MI (Modification Indices) values, the fit indices of the analyzed model were obtained as follows: RMSEA=.071; SRMR=.071; CMIN\DF=2,535; GFI=.809; CFI=.911; AGFI=.879; NFI=.904; χ^2=1232,128; *df*=486 and *p*=.000. This result shows that the fit values of the model are acceptable and at the desired level (Bayram, 2010; Byrne, 2010; Kline, 2005; Şimşek, 2007).

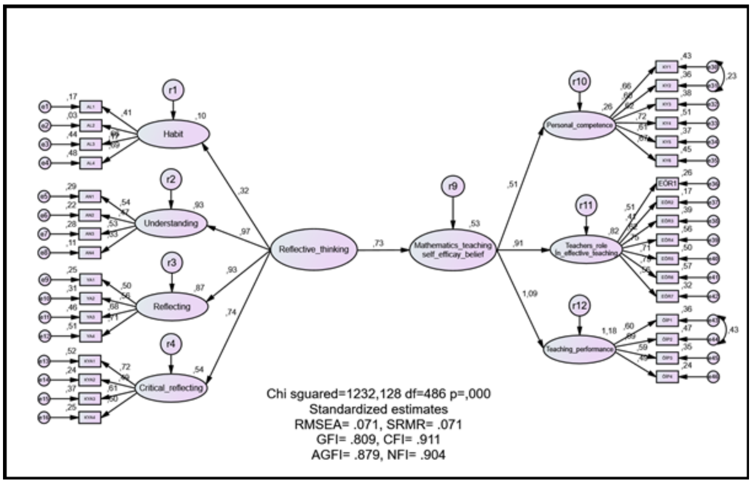
The standardized beta, standard error and significance values of the path from the latent variable of reflective thinking to the latent variable of mathematics teaching self-efficacy belief are shown in Table 3. According to these findings, reflective thinking has a significant effect on mathematics teaching self-efficacy belief.

Table 3
Path Coefficients of Basic Model

Path	Standardize β	SE	*p*
Reflective Thinking → Mathematics Teaching Self Efficacy Belief	.73	.03	***

Considering the standardized regression (Beta) coefficients in the model in Figure 1 obtained as a result of the analysis; reflective thinking has a positive effect on mathematics teaching self-efficacy belief (β= 0.73; *p*<.05). This result indicates the confirmation of the hypothesis of "Reflective thinking and mathematics teaching affect self-efficacy beliefs positively and significantly." in H1. In addition, it is seen that reflective thinking explains the mathematics teaching self-efficacy belief by 53%. In other words, it can be said that the change in mathematics teaching self-efficacy beliefs of prospective primary school teachers depends on their reflective thinking perceptions at a rate of 53%. This result confirms the hypothesis of "Reflective thinking and mathematics teaching explains self-efficacy belief significantly." in H2.

Figure 1
Model Diagram of The Effects of Reflective Thinking on Mathematics Teaching Self-Efficacy Belief



Mediating Model Results

In the mediating model shown in Figure 2, one of the structural equation models, the latent variable of reflective thinking was taken as independent, the latent variable of mathematics teaching self-efficacy belief was taken as the dependent variable, and the latent variable of questioning ability was taken as the mediating variable. Thus, both the existence of the effects related to the mediating role and the accuracy of the research hypotheses were investigated.

According to the results of the mediating model shown in Figure 2, the fit indices of the analyzed model -taking into account the MI (Modification Indices) values- were obtained as follows: RMSEA=.071; SRMR=.690; CMIN\df=2,525; GFI=.848; CFI=.907; AGFI=.896; NFI=.889; χ^2=2573,241; *df*=1019 and *p*=.000. This result shows that the fit values of the model are acceptable and at the desired level. The standardized beta, standard error and significance values of the paths specified in the model are shown in Table 4.

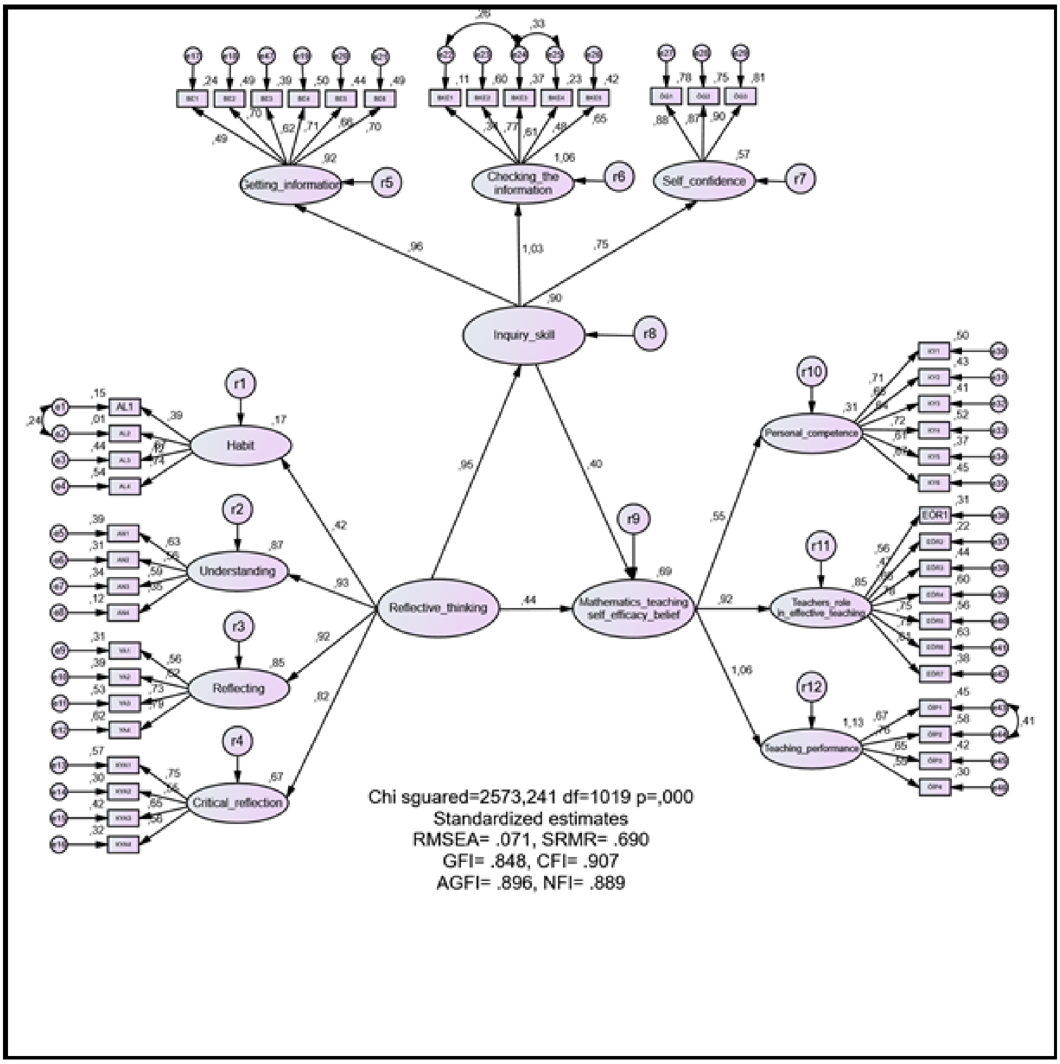
Table 4
Path Coefficients of Mediation Model

Path			Standardize *β*	*SE*	*p*
Reflective thinking	→	Inquiry skill	.95	.04	***
Reflective thinking	→	Mathematics teaching self-efficacy belief	.44	.04	***
Inquiry skill	→	Mathematics teaching self-efficacy belief	.40	.05	***

According to these findings, the perception of reflective thinking significantly affects the perception of inquiry skills (standardized β = 0.95; *p*<.05), and the perception of inquiry skills significantly affects mathematics teaching self-efficacy belief (standardized β = 0.40; *p*<.05). In addition to all these, the effect of reflective thinking on mathematics teaching self-efficacy belief decreased with the inclusion of inquiry skills in the model (standardized β = 0.44; *p*<.05). This result shows the correctness of the hypothesis of "Inquiry skill has a partial mediation effect between reflective thinking and mathematics teaching self-efficacy belief" in H7.

Figure 2

Model Diagram of The Reflective Thinking on Inquiry Skill and Mathematics Teaching Self-Efficacy Belief



Considering the other hypotheses of the research, the following results were obtained:

Considering the standardized regression (Beta) coefficients in the model obtained as a result of the research and in Figure 2, it is seen that reflective thinking has a positive and significant effect on the inquiry skill (β= 0.95; $p<.05$). This result confirms the hypothesis of "Reflective thinking positively and significantly affects the inquiry skill." in H3. In addition, when we look at the level of reflective thinking explaining the inquiry skill, it is seen that reflective thinking explains the inquiry skill by 90%. In other words, it can be said that 90% of the change in prospective primary school teachers' perceptions of inquiry skills depends on their reflective thinking levels. This result confirms the hypothesis of "Reflective thinking meaningfully explains the inquiry skill." in H4.

Regarding the fifth hypothesis of the study, when the standardized regression (Beta) coefficients in the model are examined, it is understood that inquiry skill has a positive and significant effect on mathematics teaching self-efficacy belief (β= 0.40; *p*<.05). This result demonstrates the accuracy of the hypothesis stated in H5 that "Inquiry skill affects mathematics teaching self-efficacy belief positively and significantly". Another finding that stands out in the model proposed above is that the latent variables of reflective thinking and inquiry skills together explain the latent variable of mathematics teaching self-efficacy belief as significant at the rate of 69%. In other words, it was revealed that the change in mathematics teaching self-efficacy beliefs of prospective primary school teachers was related to their perceptions of reflective thinking and inquiry skills at a rate of 69%. This finding shows that reflective thinking and inquiry skills are important predictors on mathematics teaching self-efficacy belief. This result reveals the accuracy of the hypothesis in H6 that "Reflective thinking and inquiry skills together explain mathematics teaching self-efficacy belief at a high level and meaningfully".

Discussion

This study aims to show to what extent the variables of reflective thinking, inquiry skill and mathematics teaching self-efficacy belief affect each other, to show their rates of explaining each other, and to show whether inquiry skill is a mediating variable in the relationship between reflective thinking and mathematics teaching self-efficacy belief. In this context, the study discussed the effects of prospective primary school teachers' reflective thinking, inquiry skills, and mathematics teaching self-efficacy belief levels on each other and their levels of explaining each other.

Teachers need to learn new skills such as problem-solving, creativity, critical thinking, cooperation, and communication, which are accepted as 21st-century skills, both in terms of improving the quality and reflecting this on student outcomes. Regarding the first and second hypotheses of the study, it was found that reflective thinking affected and explained mathematics teaching self-efficacy belief positively and significantly. It was also found that reflective thinking explained mathematics teaching self-efficacy belief by 53%. In other words, high reflective thinking has a positive effect on prospective primary school teachers' mathematics teaching self-efficacy belief. Reflective thinking skill shows that the teacher is confident about his/her mathematics teaching skills. It also enables prospective teachers to be open to new ideas, improve their classroom behaviors and to develop positive attitudes towards teaching. It is important for prospective primary school teachers who may encounter many problems in their professional lives to have high self-efficacy beliefs since they will struggle to overcome these obstacles. Prospective teachers with high mathematics self-efficacy perceptions are expected to become persistent teachers, who can deal with problems, and who do not give up easily after they graduate. Unlike this study, Gözel and Toptaş (2017) found a significant and positive weak correlation between prospective primary school teachers' self-efficacy beliefs about mathematics teaching and their reflective thinking skills. According to this, it can be said that participants carry out low levels of reflective thinking during mathematics teaching practices. In Sevgi and Zihar's (2020) study, a moderate, positive, and significant correlation was found between secondary school students' reflective thinking skills related to problem-solving and their mathematics self-efficacy perception. Demirtaş and Menşan (2021) found a positive and significant correlation between prospective primary school teachers' high-level thinking skills and their problem-solving beliefs. Tunç and Kıncal (2021) found a positive moderate correlation between preschool teachers' reflective thinking tendencies and their self-efficacy beliefs. Regarding the effect of self-efficacy on reflection, Thoonen et al. (2011) observed that teachers' self-efficacy beliefs were the strongest motivation in explaining teachers' experiences and reflections. Reflection is considered an important tool in the professional development of teachers (Burton, 2009). In a study conducted on prospective teachers, Norton (1997) found a positive association between effective teaching and reflective thinking. The development of reflective thinking forms the center of mathematics teaching (Meissner, 2006). Therefore, gaining reflective thinking skills seems to be important in mathematics teaching. In literature, it has been shown that reflective thinking is important in terms of mathematics teaching (García et al., 2007; Kramarski et al., 2013) and reflective thinking supports significant learning in mathematics (Inoue & Buczynski, 2011; McNaught, 2010). Thus, it can be said that prospective teachers with high reflective thinking skills will have high mathematics teaching self-efficacy beliefs.

In mathematics lessons, teachers should guide their students to think reflectively during the problem-solving process, and they should ensure that their students question and evaluate what they do and establish cause-effect relationships between events and concepts. It is important to investigate the reflective thinking skills of prospective teachers which will enable them to think about parts they find themselves competent and incompetent by questioning what they will teach and why during their teaching process in terms of their professional development (Dewey, 1933; Schön, 1983). Regarding the third and fourth hypotheses of the study, it was concluded that reflective thinking explained 90% of inquiry skills. Therefore, teachers can make use of inquiry to develop students' reflective skills. Similar to this result, Dindar (2018) found a positive and significant correlation between prospective teachers' inquiry skills and their reflective thinking tendencies. Individuals who have reflective thinking skills can associate thoughts about their previous/present and future experiences, they can question, they can evaluate themselves and situations and they responsible for their learning as a part of the learning experience. Reflective thinking is a skill that can be developed by using various methods (Wilson & Jan, 1993). Taggart and Wilson (2005) claimed that teachers' reflective thinking skills can be developed by using techniques such as brainstorming, cooperating with others, and inquiry. However, it is important for a teacher who wants to develop students' reflective thinking skills to have these skills because teachers who have reflective thinking skills support and guide their students (Wilson & Jan, 1993). Reflective thinking is generally the result of teaching (Meissner, 2006). Teachers with reflective teaching can prepare a teaching environment suitable for their students' needs by preparing reflective thinking environments. According to Ersözlü and Kazu (2011), as with many other skills, the earlier reflective thinking is acquired, the more effective it can be. For this reason, starting from primary education, students should be taught these skills and thus a basis should be prepared for students to improve these skills in their future school life.

Regarding the fifth hypothesis of the study, it was concluded that inquiry skills affected mathematics teaching self-efficacy belief positively and significantly. Therefore, prospective teachers' inquiry skills have a positive effect on their mathematics teaching competence. This is because while questioning themselves, individuals compare previous knowledge with what they learn, they activate their prior knowledge, see their weaknesses and strengths in understanding the subject and think about how they can complete these in the best way. While performing a task, they see the steps they follow the methods they use, and the advantages and disadvantages of these and evaluate them. To be able to use inquiry effectively, teachers should tailor the questions according to students' level, needs and in parallel with the subject. Considering the students that prospective primary school teachers will educate in the future, prospective teachers will need to have high inquiry skills and include inquiry-based practices frequently in their classes. This is because with inquiry-based experiences, skills are internalized, and these skills become a part of students' mental structure. For this reason, for meaningful learning to occur, students should be provided with the opportunity to experience something and thus knowledge and skills should be internalized.

Regarding the sixth and seventh hypotheses of the study, it was concluded that reflective thinking and inquiry skill together explained mathematics teaching self-efficacy belief significantly with a rate of 69%. This result shows that reflective thinking and inquiry skill are significant predictors (explanatory) of inquiry skills. Therefore, prospective primary school teachers' being individuals with reflective thinking and inquiry skills affect their mathematics teaching competence significantly. Mathematics teaching self-efficacy belief of prospective primary school teachers is individuals' belief in their abilities and capacity. Self-efficacy belief shows that prospective primary school teachers consider themselves competent about mathematics teaching and they believe that they can teach effectively. Mathematics teaching self-efficacy belief of prospective primary school teachers expresses teachers' beliefs that they will show the required behaviors so that they can successfully perform the teaching process. It is possible for primary school teachers, who will teach basic knowledge and skills in mathematics teaching to their students, to educate their students as reflective thinking and questioning individuals through including reflective thinking and inquiry in mathematics teaching. It can be said that teachers who have the desired self-efficacy belief have a high level of satisfaction, they tend to their profession more, they trust their teaching ability, they perform their teaching functions more successfully, they believe that learning can be affected by effective teaching, they can persist for a longer time by experiencing professional stress less, and they can provide different feedback to students who have difficulty in education and learning.

Suggestions

It is thought that in terms of conducting a more detailed identification of causes that affect the reflective thinking and inquiry skills of prospective teachers, using qualitative data such as observations and interviews in addition to quantitative data will develop a multi-dimensional perspective. For this reason, it seems to be important to conduct studies in which qualitative data are obtained. The general objective of teacher education programs is to create behavioral changes in prospective teachers that can be reflected on their students. For this reason, it can be recommended for academic staff educating prospective teachers to improve themselves about reflective thinking and inquiry skills. It seems important to provide practical training for future teachers in faculties of education to develop their reflective thinking and inquiry skills. In faculties of education, educational programs should be prepared to develop reflective thinking and inquiry skills in prospective teachers. It is an important requirement for teachers to gain reflective thinking skills in prospective primary school teachers training since reflective thinking training will enable prospective teachers to develop both their own and their future students' reflective thinking skills in their professional practice.

Conclusions

Reflective thinking and mathematics teaching affect self-efficacy beliefs positively and significantly. Reflective thinking and mathematics teaching explains self-efficacy belief significantly. Reflective thinking positively and significantly affects the inquiry skill. Reflective thinking meaningfully explains the inquiry skill. Inquiry skill affects mathematics teaching self-efficacy belief positively and significantly. Reflective thinking and inquiry skills together explain mathematics teaching self-efficacy belief at a high level and meaningfully. Inquiry skill has a partial mediation effect between reflective thinking and mathematics teaching self-efficacy belief.

References

Abdi, A. (2014). The effect of inquiry-based learning method on students' academic achievement in science course. *Universal Journal of Educational Research, 2*(1), 37-41. https://doi.org/10.13189/ujer.2014.020104

Akar, D., & Şahin, Ç. (2020). Sınıf öğretmenlerinin yansıtıcı düşünme eğilimleri [Reflective thinking dispositions of experienced and novice classroom teachers]. *Ahi Bilge Eğitim Dergisi, 1*(1), 15-32.

Akay, H., & Boz, N. (2011). Sınıf öğretmeni adaylarının matematiğe yönelik tutumları, matematiğe karşı öz-yeterlik algıları ve öğretmen öz-yeterlik inançları arasındaki ilişkilerin incelenmesi [Examining the relationships among prospective primary school teachers' attitude towards mathematics, mathematics self-efficacy beliefs, teacher self-efficacy beliefs]. *The Journal of Turkish Educational Sciences, 9*(2), 281-312.

Akpullukçu, S. (2011). *Fen ve teknoloji dersinde araştırmaya dayalı* öğrenme *ortamının* öğrencilerin *akademik başarı, hatırda tutma düzeyi ve tutumlarına etkisi* [The effect of inquiry-based learning environment in science and technology course on the students' academic achievements, attitudes and retention level] [Unpublished master's thesis]. University of Dokuz Eylül.

Aldan-Karademir, Ç., & Saracaloğlu, A. S. (2013). Sorgulama becerileri ölçeği'nin geliştirilmesi: Geçerlik ve güvenirlik çalışması [The development of inquiry skills scale: Reliability and validity study]. *Asian Journal of Instruction, 1*(2), 56-65.

Alkan, V., & Gözel, E. (2013). Sınıf öğretmeni adaylarının yansıtıcı düşünme becerilerine ilişkin görüşleri [The prospective primary school teachers' views about reflective thinking skills]. *e-Journal of New World Sciences Academy, 8*(1), 1-12.

Aras, B., Şiringül, İ., & Park, F. (2019). Öğretmen adaylarının yansıtıcı düşünme düzeylerinin bazı değişkenlere göre incelenmesi [Investigating reflective thinking levels of prospective teachers according to some variables]. *International Journal of Science and Education, 1*(2), 119-130.

Arseven, A., Arseven, İ., & Tepehan, T. (2015). Sınıf öğretmeni adaylarının matematik öğretimine yönelik öz-yeterlik algılarının incelenmesi [Examination of class teacher candidates' mathematics teaching self-efficacy]. *Cumhuriyet International Journal of Education*, *4*(2), 29-40. https://doi.org/10.30703/cije.321367

Bağcaz, E. (2009). *Sorgulayıcı* öğretim *yönteminin* öğrencilerin *akademik başarısı ve fen ve teknoloji dersine yönelik tutumuna etkisi* [The effect of inquiry teaching method on students' academic success and on attitude for the science and technology lesson] [Unpublished master's thesis]. University of Sakarya.

Balım, A. G., İnel, D., & Evrekli E. (2008). Fen öğretiminde kavram karikatürü kullanımının öğrencilerin akademik başarılarına ve sorgulayıcı öğrenme becerileri algılarına etkisi [The effects the using of concept cartoons in science education on students' academic achievements and enquiry learning skill perceptions]. *Elementary Education Online, 7*(1), 188-202.

Baş, G., & Kıvılcım, Z. S. (2013). Lise öğrencilerinin problem çözmeye yönelik yansıtıcı düşünme becerileri ile matematik ve geometri derslerindeki akademik başarıları arasındaki ilişki [The correlation between reflective thinking skills towards problem solving and academic success in mathematics and geometry courses of high school students]. *Ahi Evran University Journal of Kırşehir Education Faculty, 14*(3), 1-17.

Başol, G., & Evin-Gencel, İ. (2013). Yansıtıcı düşünme düzeyini belirleme ölçeği: Geçerlik ve güvenirlik çalışması [Reflective thinking scale: A validity and reliability study]. *Educational Sciences: Theory & Practice, 13*(2), 929-946.

Bayram, N. (2010). *Yapısal eşitlik modellemesine giriş: Amos uygulamaları.* [Introduction to structural equation modeling: Amos applications]. Ezgi Publishing.

Bell, R. L., Smetana, L., & Binns, I. (2005). Simplifying inquiry instruction. *The Science Teacher, 72*(7), 30-33.

Birgin, O. (2016). Matematik öğrenmeye ilişkin inanç ölçeğinin geliştirilmesi: Geçerlik ve güvenirlik çalışması [Development of the belief scale towards mathematics learning: A study of validity and reliability] *Proceedings of first INES International Academic Research Congress* (pp. 3916-3923). Pegem Academy Publishing.

Branch, J. L., & Solowan, D. G. (2003). Inquiry-based learning: The key to student success. *School Libraries in Canada, 22*(4), 6-12.

Budak Bayır, E. (2008). *Fen müfredatlarındaki yeni yönelimler ışığında öğretmen eğitimi: Sorgulayıcı-araştırma odaklı kimya öğretimi* [Teacher education in the light of new tendencies in science curriculum: Inquiry-based chemistry teaching] [Unpublished doctoral dissertation]. University of Gazi.

Burton, J. (2009). Reflective practice. In A. Burns, & J. C. Richards (Eds.), *The Cambridge guide to second language teacher education* (pp. 298-307). Cambridge University Press.

Büyüköztürk, Ş. (2012). *Sosyal bilimler için veri analizi el kitabı.* [Manual of data analysis for social sciences]. Pegem Academy Publications.

Byrne, B. M. (2010). *Structural equation modeling with AMOS: Basic concepts, applications and programming.* Taylor and Francis Group.

Chung, H. M., & Behan, K. J. (2010). Peer sharing facilitates the effect of inquiry-based projects on science learning. *The American Biology Teacher, 72*(1), 24-29. https://doi.org/10.1525/abt.2010.72.1.7

Çağırgan-Gülten, D., Özsoy-Güneş, Z., & Kırbaşlar, F. G. (2012, September 12-14). *Matematik* öz-yeterlik *algısının* çeşitli *değişkenler açısından değerlendirilmesine yönelik bir* çalışma [A study to evaluate the perception of mathematics self-efficacy in terms of various variables] [Conference presentation] X. UFBMEK National Science and Mathematics Education Congress, İstanbul, Turkey.

Çelik, B. B., & Dikmenli, Y. (2021). Sınıf öğretmeni adaylarının yaratıcı ve yansıtıcı düşünme eğilimlerinin incelenmesi [Investigating creative and reflective thinking trends of class teacher candidates]. *Anadolu Kültürel Araştırmalar Dergisi, 5*(1), 46-65. https://doi.org/10.15659/anka d.v5i1.101

Çeliksöz, M. (2012). *Farklı düzeylerdeki sorgulayıcı-araştırmaya dayalı öğretim yöntemlerinin ilköğretim öğrencilerinin başarı, tutum, bilimsel süreç becerisi ve bilgi kalıcılıklarına etkileri* [The effects of inquiry-based teaching methodologies at different levels on primary school students' achievement, attitudes, scientific process skills and retention of knowledge] [Unpublished master's thesis]. University of Trakya.

Davies, D. J., Collier, C., & Howe, A. (2012). A matter of interpretation: Developing primary pupils' enquiry skills using position-linked datalogging. *Research in Science & Technological Education, 30*(3), 311-325. https://doi.org/10.1080/02635143.2012.738420

Demirtaş, B., & Menşan, N. Ö. (2021). Sınıf öğretmeni adaylarının üst düzey düşünme becerileri ile problem çözmeye ilişkin inançları arasındaki ilişki [The relationship between the high-level thinking skills and the faith of problem-solving of the primary school teacher candidates]. *International Journal of Primary Education Studies, 2*(1), 43-52.

Dewey, J. (1933). *How we think. A restatement of the relation of reflective thinking to the educative process.* Heath & Co Publishers.

Dindar, S. (2018). *Okul* öncesi öğretmen *adaylarının sorgulama becerileri ile yansıtıcı düşünme eğilimleri asasındaki ilişkinin incelenmesi* [Examining the relationship between inquiry skills of preschool teacher candidates and reflective thinking tendencies] [Unpublished master's thesis]. University of Okan.

Duban, N. (2008). *İlköğretim fen ve teknoloji dersinin sorgulamaya dayalı öğrenme yaklaşımına göre işlenmesi: Bir eylem araştırması* [Conducting science and technology course through inquiry-based learning approach in primary education: An action research] [Unpublished doctoral dissertation]. University of Anadolu.

Enochs, L., Smith, P. L., & Huinker, D. (2000). Establishing factorial validity of the mathematics teaching efficacy beliefs instrument. *School Science and Mathematics*, *100*(4), 194-202. https://doi.org/10.1111/j.1949-8594.2000.tb17256.x

Erdoğan, M. N. (2005*). İlköğretim 7. sınıf öğrencilerinin atomun yapısı konusundaki başarılarına, kavramsal değişimlerine, bilimsel süreç becerilerine ve fene karşı tutumlarına sorgulayıcı-araştırma yönteminin etkisi* [The effects of inquiry method on middle school (level 7) students' achievement, conceptual change, scientific process skills and attitude toward science about the atomic structure] [Unpublished master's thesis]. University of Gazi.

Ersözlü, Z. N., & Kazu, H. (2011). İlköğretim beşinci sınıf sosyal bilgiler dersinde uygulanan yansıtıcı düşünmeyi geliştirme etkinliklerinin akademik başarıya etkisi [The effects of reflective thinking activities on the academic successes of fifth grade primary social studies students]. *Journal of Uludag University Faculty of Education, 24*(1), 141-159.

Evrekli, E. (2010). *Fen ve Teknoloji öğretiminde zihin haritası ve kavram karikatürü etkinliklerinin öğrencilerin akademik başarılarına ve sorgulayıcı öğrenme becerileri algılarına etkisi* [The effects of mind map and concept cartoon activities in science and technology education on students' academic achievement and inquiry learning skill perceptions] [Unpublished master's thesis]. University of Dokuz Eylül.

Evren, B. (2012). *Fen ve teknoloji öğretiminde sorgulayıcı öğrenme yaklaşımının öğrencilerin sahip oldukları eleştirel düşünme eğilim düzeylerine ve fen ve teknoloji dersine yönelik tutumlarına etkisi* [The effect of inquiry learning approach on elementary students' critical thinking dispositions and attitudes towards science and technology course] [Unpublished master's thesis]. University of Adnan Menderes.

García, M., Sánchez, V., & Escudero, I. (2007). Learning through reflection in mathematics teacher education. *Educational Studies in Mathematics, 64*(1), 1-17. https://doi.org/10.1007/s10649-006-9021-9

Gençtürk, H. A. (2004). *Sorgulama yöntemiyle fen bilgisi dersi öğretiminin ilköğretim okullarında uygulaması* [Teaching elementary science courses with inquiry-teaching method at the primary schools] [Unpublished master's thesis]. University of Afyon Kocatepe.

Gipe, J. P., & Richards, J. C. (1992). Reflective thinking and growth in novices' teaching abilities. *Journal of Educational Research*, *86*(1), 52-57. https://doi.org/10.1080/00220671.1992.9941827

Gözel, E., & Toptaş, V. (2017). Sınıf öğretmeni adaylarının matematik öğretimi yeterlik inançları ile yansıtıcı düşünme becerileri arasındaki ilişki [The relationship between mathematical teaching efficacy beliefs and reflective thinking skills of prospective primary school teachers]. *Cumhuriyet International Journal of Education, 6*(4), 412-425. https://doi.org/10.30703/cije.327172

Güngör Seyhan, H. (2008). *Kimya eğitiminde sorgulamaya dayalı öğrenci deneylerinin geliştirilmesi ve sonuçlarının tartışılması* [Developing inquiry-based student experiments in the chemistry education and discussing results] [Unpublished master's thesis]. University of Gazi.

Hacıömeroğlu, G., & Şahin-Taşkın, Ç. (2010). Sınıf öğretmeni adaylarının matematik öğretimi yeterlik inançları [Elementary preservice teachers' mathematics teaching efficacy belief]. *Journal of Uludag University Faculty of Education, 23*(2), 539-555.

Hair, J. F., Anderson, R. E., Tatham, R. L., & Black, W. C. (1998). *Multivariate data analysis* (5th ed.). Prentice-Hall International.

Inoue, N., & Buczynski, S. (2011). You asked open-ended questions, now what? Understanding the nature of stumbling blocks in teaching inquiry lessons. *The Mathematics Educator, 20*(2), 10-23.

Kaf-Hasırcı, Ö., & Sadık, F. (2011). Sınıf öğretmenlerinin yansıtıcı düşünme eğilimlerinin incelenmesi [Examining the reflective thinking dispositions of classroom teachers]. Çukurova *University Journal of Social Sciences, 20*(2), 195-210.

Kara, K. (2008*). İlköğretim 3. sınıf hayat bilgisi dersinde sorgulama merkezli etkinliklerle yapılan proje çalışmalarındaki öğrenci performansının değerlendirilmesi* [The evaluation of student performance on the projects which are based on inquiry in the third-grade life studies course] [Unpublished master's thesis]. University of Çukurova.

Karapınar, A. (2016). *Sorgulamaya dayalı* öğrenme *ortamının* öğretmen *adaylarının bilimsel süreç becerileri, sorgulama becerileri ve bilimsel düşünme yetenekleri* üzerindeki *etkisi* [The impact of inquiry-based learning environment on scientific process skills, inquiry skills and scientific reasoning skills of prospective schoolteachers] [Unpublished master's thesis]. University of Celal Bayar.

Karasar, N. (2012). *Bilimsel araştırma yöntemi* [Scientific research method]. Nobel Publishing.

Kember, D., Leung, D., Jones, A., Loke, A., McKay, J., Sinclair, K., Tse, H., Webb, C., Wong, F., Wong, M., & Yeung, E. (2000). Development of a questionnaire to measure the level of reflective thinking. *Assessment and Evaluation in Higher Education, 25*(4), 381-395. https://doi.org/10.1080/713611442

Kızılkaya, G., & Aşkar, P. (2009). Problem çözmeye yönelik düşünme becerisi ölçeğinin geliştirilmesi [The development of a reflective thinking skill scale towards problem solving]. *Education and Science, 34*(154), 82-92.

Kramarski, B., Weiss, I., & Sharon, S. (2013). Generic versus context-specific prompts for supporting self-regulation in mathematical problem solving among students with low or high prior knowledge. *Journal of Cognitive Education and Psychology, 12*(2), 197-214. https://doi.org/10 .1891/1945-8959.12.2.197

Küçük, H. (2012). *İlköğretimde bilimsel tartışma destekli sınıf içi etkinliklerin kullanılmasının öğrencilerin kavramsal anlamalarına, sorgulayıcı öğrenme becerileri algılarına ve fen ve teknolojiye yönelik tutumlarına etkisi* [The effect of using argumentation supported classroom activities in elementary education on students' conceptual understandings, inquiry learning skill perceptions and attitudes towards science and technology] [Unpublished master's thesis]. University of Muğla Sıtkı Koçman.

Lawson, A. E. (2010). *Teaching inquiry science in middle and secondary schools.* Sage Publications.

Llewellyn, D. (2002). *Inquiry within: Implementing inquiry-based science standards.* Corwin Press.

Mahnaz, M. (1997). Content and nature of reflective teaching: A case of an experiment middle school science teacher. *Clearing House*, *70*(3), 143-151. https://doi.org/10.1080/00098655.1997.10543 914

McNaught, K. (2010). Reflective writing in mathematics education programmes. *Reflective Practice, 11*(3), 369-379. https://doi.org/10.1080/14623943.2010.487373

Meissner, H. (1999, July 15-19). *Creativity and mathematics education* [Conference presentation]. Creativity and Mathematics Education of the International Conference, Muenster, Germany.

Ministry of National Education [MoNE]. (2018). Milli Eğitim Bakanlığı Talim ve Terbiye Kurulu Başkanlığı Matematik Dersi Öğretim Programı [Ministry of National Education Board of Education and Training mathematics curriculum], Ankara.

Norton, J. L. (1997). Locus control and reflective thinking in preservice teachers. *Education, 117*(3), 401-410.

Reisinger, Y., & Mavondo, F. (2007). Structural equation modeling: Critical issues and new developments. *Journal of Travel & Tourism Marketing, 21*(4), 41-71. https://doi.org/10.1300/J0 73v21n04_05

Sağlam, S. (2012). *Lisans öğrencilerinin RNA teknolojileri konusundaki bilgi seviyeleri ve sorgulamaya dayalı öğrenme yaklaşımıyla sunulan materyalin etkisi* [Knowledge levels of undergraduate students about RNA technologies and the effect of materials presented through inquiry-based learning approach] [Unpublished master's thesis]. University of Gazi.

Schermelleh-Engel, K., Moosbrugger, H., & Müller, H. (2003). Evaluating the fit of structural equation models: Tests of significance and descriptive goodness-of-fit measures. *Methods of Psychological Research Online, 8*(2), 23-74.

Schön, D. (1987). *Educating the reflective practitioner: Toward a new design for teaching and learning in the professions*. Jossey Bass.

Sevgi, S., & Zihar, M. (2020). Ortaokul öğrencilerinin yansıtıcı düşünme becerileri ile matematik öz yeterlik algılarının çeşitli değişkenler açısından incelenmesi [Analyzing the reflective thinking skills and mathematical self-efficacy perceptions of middle school students with respect to some variables]. *Kastamonu Education Journal, 28*(6), 2331-2345. https://doi.org/10.24106/kefdergi.700428

Sözen, K. (2010). *Sorgulayıcı öğrenme ve programlı öğretim yöntemlerine göre işlenen biyoloji laboratuvarı uygulamalarının karşılaştırılması* [The comparison of biology laboratory applications done according to inquiry learning and programmed teaching] [Unpublished master's thesis]. University of Sakarya.

Swars, S., Hart, L. C., Smith, S. Z., Smith, M. E., & Tolar, T. A. (2007). Longitudinal study of elementary pre-service teachers' mathematics beliefs and content knowledge. *School Science and Mathematics*, *107*(9), 325-335. https://doi.org/10.1111/j.1949-8594.2007.tb17797.x

Şen, H. C. (2010). *Bir öğrenci özellikleri-uygulama etkileşimi çalışması: sorgulama temelli öğretim ve düz anlatım metotlarıyla öğretimin lise öğrencilerinin fizik başarısı üzerindeki etkisi* [An aptitude treatment interaction study: The effect of inquiry-based instruction and lecture instruction on high school students' physics achievement] [Unpublished doctoral dissertation]. Middle East Technical University.

Şimşek, Ö. F. (2007). *Yapısal eşitlik modellemesine giriş. Temel ilkeler ve LISREL uygulamaları* [Introduction to structural equation modeling. Basic principles and applications of LISREL]. Ekinoks Publications.

Taggart, G. L., & Wilson, A. P. (2005). *Promoting reflective thinking in teachers: 50 action strategies.* Corwin Press.

Taşkoyan, S. N. (2008). *Fen ve teknoloji öğretiminde sorgulayıcı öğrenme stratejilerinin öğrencilerin sorgulayıcı öğrenme becerileri, akademik başarıları ve tutumları üzerindeki etkisi* [The effect of inquiry learning strategies on students' skills of inquiry learning, academic success and attitudes] [Unpublished master's thesis]. University of Dokuz Eylül.

Thoonen, E. E. J., Sleegers, P. J. C., Oort, F. J., Peetsma, T. T. D., & Geijsel, F. P. (2011). How to improve teaching practices: The role of teacher motivation, organizational factors, and leadership practices. *Educational Administration Quarterly, 47*(3), 496-536. https://doi.org/10.1177/0013161X11400185

Timur, B. (2005*). İlköğretim 7. sınıf fen bilgisi dersinde sorgulamalı öğretimin öğrenci başarısına etkisi* [The effect of inquiry teaching on student achievement in 7th grade science courses] [Unpublished master's thesis]. University of Çanakkale Onsekiz Mart.

Toluk-Uçar, Z., Pişkin, M., Akkaş, E. N., & Taşçı, D. (2010). İlköğretim öğrencilerinin matematik, matematik öğretmenleri ve matematikçiler hakkındaki inançları [Elementary students' beliefs about mathematics, mathematics' teachers and mathematicians]. *Education and Science*, *35*(155), 131-144.

Tunç, Y., & Kıncal, R. Y. (2021). Okul öncesi öğretmenlerinin yansıtıcı düşünme eğilimleri ile öz yeterlik inançları arasındaki ilişkinin incelenmesi [Investigation of the relationship between reflective thinking tendencies and self-efficiency beliefs of preschool teachers]. *The Journal of Academic Social Science, 9*(113), 249-267. http://dx.doi.org/10.29228/ASOS.48926

Varlı, B., & Uluçınar-Sağır, Ş. (2019). Araştırma sorgulamaya dayalı öğretimin ortaokul öğrencilerinin fen başarısı, sorgulama algısı ve üstbiliş farkındalığına etkisi [The effect of inquiry-based teaching on secondary school students' science success, questioning perception and metacognitive awareness]. *Gazi University Journal of Gazi Educational Faculty, 39*(2), 703-725. https://doi.org/10.17152/gefad.407417

Wilson, J., & Jan, L. W. (1993). *Thinking for themselves: Developing strategies for reflective learning.* Eleanor Curtain Publishing.

Yıldırım, A., & Şimşek, H. (2013). *Sosyal bilimlerde nitel araştırma yöntemleri* [Qualitative research methods in the social sciences]. Seçkin Publishing.

Received: *October 23, 2021* Accepted: *January 24, 2022*

Cite as: Saracoglu, M. (2022). Reflective thinking and inquiry skills as predictors of self-efficacy in teaching mathematics. *Problems of Education in the 21st Century*, *80*(1), 213-231. https://doi.org/10.33225/pec/22.80.213

Mehtap Saracoglu PhD, Assistant Professor, Faculty of Education, Siirt University, Kezer Kampüsü, 56100, Merkez, Siirt, Turkey.
E-mail: mehtapsarac@siirt.edu.tr
ORCID: http://orcid.org/0000-0002-2460-9529

GUIDE FOR AUTHORS

ISSN 1822-7864 /print/ ISSN 2538-7111 /Online/

General Information

The publication language is English. All authors must take care of the language revision on their own. The language must be clear and accurate. The work should be written in an impersonal style. The editor reserves the right to send the manuscript to be reviewed. If English is a second language for the author, please consider having the manuscript proof read and edited before submitting.

Format of Manuscripts

Title

The main research idea/problem should be reflected in the title. The title should show the nature of the research/study. It is recommended to avoid the title of the question form. The recommended length for a title is no more than 12 words (APA, 2.01, p. 23).
The title of the paper 14-point, bold with capital letters, align left; titles in the text (chapters) 12-point bold, not numbered; sub-titles (subchapters) 12-point, italic, not numbered. There must be 1 empty line before and after a title or a subtitle. The text chapters must be separated by 1 empty row. The title should be concise and informative. Avoid abbreviations.

Author names and affiliations

Full names/surnames should be provided. Please indicate affiliations of the author(s). All the e-mails should be indicated below.

Abstract

The first page of the manuscript must begin with the title of the paper and an abstract which should be about 150 - 250 words. For the papers reporting original research, state in brief: the primary/main aim (the research questions addressed or any hypothesis tested); the research design; the methods and procedures employed; the number of participants; the main outcomes and results; the conclusions drawn from these data and results, including their implications for further research or application/practice. An abstract represents briefly a content of a text. Do not cite references in the abstract. The abstract should grip the reader's attention.

Keywords

Please provide 3 to 5 keywords in alphabetical order. Note that a keyword does not have to be made of only one word. At least one of these should indicate the topic area and one should indicate the methodology of the research.

The structure of the manuscript (recommended)

The body of the text of the manuscript must generally have the following parts:
- abstract + keywords;
- introduction (it can be divided into some subchapters if needed);
- methodology of research (it is recommended to divide /rubricate);
- results of research;
- discussion;
- conclusions and/or implications;
- acknowledgements (if any);
- references (in APA style, 7th Ed);
- appendix (if any).

P.S. The structure can be different if the paper is only theoretical qualitative research.

The length of the manuscript

The manuscript should be not shorter than 6 pages (including references, tables and figures). Manuscripts should be typed on A4, in Times New Roman 12-point font size, single-spaced, 2.5 cm with all the margins, word-document (Word 6.0 or later) format.

Acronyms

Acronyms should be defined the first time they appear.

Tables and figures

Tables and figures should be valuable, relevant, and visually attractive. Tables (made in Word or another software) and figures must be referred to in the text and numbered in the order of their appearance. Each table and figure should have a complete, descriptive title; and each table column an appropriate heading. The texts in tables and figures should be 11-point (in some cases 10) and their width should be 12 cm at maximum. The figures should be in format .jpg (unless done in Word or Excel); resolution 1200 dpi. Figures, tables (black and white colour, without ground-colour) and captions should be inserted within the manuscript at their appropriate locations. All the graphics (figures) must be editable. The font size should be Times New Roman for all figures and tables. Figures should be carefully explained in the text and cited in numerical order.
It is the author's responsibility to obtain permission to reproduce illustrations, tables, etc. from other publications.

Discussion

Focus the discussion to the two important questions: What is already known about your topic? What your research adds? It is recommended that the aim and major findings of the research should be reminded. And then the similarities and differences of the findings with previous research studies should be exemplified in detail.

Conclusions

This part is not a summary. Bring out the significance of your research. Show how you've brought closure to the research problem, and point out remaining gaps in knowledge by suggesting issues for further research. The main research outcome should be clearly seen.

References

The title „References“ must be used. APA style for writing references in the text and in the reference list must be used. References in the text should be presented in parentheses (Knox, 1988; Martin, 1995). If necessary, the page can be indicated: (Martin, 1995, p. 48). The list of references should be presented after the text.
The author should make sure that there is a strict one-to-one correspondence between the names and years in the text and those on the list. All the references should be listed in alphabeti¬cal order by author's name.
For the sake of accuracy, references should always be as updated as possible, also in the interest of the readers and researchers on the topic the paper is dealing with.

Notes

Note 1: Manuscripts in which references are not in the APAstyle will be returned without review.

Note 2: References to online sources should include the type of medium (such as "serial online" or "monograph online"), the date of that specific reference (if applicable), the uniform resource locator (URL), and the date that the source was accessed. A source accessed online should al-ways be referenced accordingly, even if it is also published in printed form.

Note 3: All papers must meet the criteria of originality and scientific quality. Obviously, they must also comply with style and format requirements. The paper will not be subject to further review, if the manuscript is NOT WITHIN THE SCOPE and/or there is POOR USAGE OF LANGUAGE (all manuscripts must be written in clear and grammatical English).

Note 4: Submitted papers will be assessed based on their novelty, technical quality, potential impact, and clarity of writing.

Note 5: All papers are checked by CrossCheck system.

Editorial Board
Updated: July 2018
Website: http://www.scientiasocialis.lt/pec/

Problems of Education in the 21st Century,
ISSN 1822-7864 (Print) ISSN 2538-7111 (Online)

Vol. 80, No. 1, 2022

Compiler	Vincentas Lamanauskas
Designer	Jurgina Jankauskienė
Paste-up artist	Loreta Šimutytė-Balčiūnienė
English language proofreader	Ilona Ratkevičienė

20 February 2022. Publishing in Quires 14.62. Edition 80.

Publisher
Scientia Socialis Ltd. in cooperation with SMC „Scientia Educologica“
Donelaicio Street 29, Siauliai, Lithuania
E-mail: scientia@scientiasocialis.lt
Phone: +370 687 95668

Printing
„Šiaulių spaustuvė“ Ltd.
9A P. Lukšio Street
LT-76207 Šiauliai, Lithuania
Phone: +370 41 500 333.
Fax: +370 41 500 336
E-mail: info@dailu.lt